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REVIEW OF TRAFFIC SOLUTIONS, CITY OF SEBASTOPOL

This report will review various traffic solutions proposed to reduce congestion at the main intersection of Main Street, Bodega Avenue and Sebastopol Avenue. All of the solutions examined utilize existing streets.

METHODOLOGY

Level of Service

The level of service concept is used to describe conditions of traffic operations. Six levels of service have been selected for application identifying the conditions existing under various speed and volume conditions on any highway or street. These levels of service, designated A to F, from best to worst, cover the entire range of traffic operations that may occur. On many specific streets and highways, the better levels cannot be attained. (Ref. 1)

The concept of level of service was introduced in the Highway Capacity Manual. Definitions for level of service for intersections are included in the appendix. Level of service for intersections is dependent upon overall delay. The concept of delay is the one most readily identified by drivers.

For planning purposes future traffic can be estimated within reasonable limits. The relationship between volume and delay for intersections has been the subject of extensive research. Since the Highway Capacity Manual was published in 1965 there have been later studies containing revised or expanded methods for determining levels of service for intersections. However, the concept (levels A through E, best to worst) has not changed.(Ref. 2)

Peak Hour Analysis

The level of service concept is related to traffic during the peak hour. In

Sebastopol the daily peak hour occurs in the afternoon, most commonly 4:30 to 5:30 PM. For this reason the analyses are done for PM peak hour traffic conditions.

Critical Volume Analysis

The method of analysis for determining the level of service of an intersection is to determine the critical lane volume for each signal phase. The sum of the critical volumes are compared to the capacity of the intersection to find level of service for that intersection. The relationship between level of service, volume to capacity and average delay are summarized below. (Ref. 2)

Level of Service	Traffic Flow Description	Critical Volume to Capacity Ratios (v/c)	Average Delay (seconds per vehicle)
A	Free Flow	0 - .60	0 - 16.0
B	Stable Flow	.61 - .70	16.1 - 22.0
C	Stable Flow	.71 - .80	22.1 - 28.0
D	Approaching Unstable Flow	.81 - .90	28.1 - 35.0
E	Unstable Flow	.91 - 1.00	35.1 - 40.0
F	Forced Flow	varies	40.1 or greater

Capacity

The capacity of a signalized intersection is the maximum number of vehicles that could pass through the intersection in an hour under prevailing conditions. The values for capacity vary with the number of phases of the signal. The more phases that a signal has the less the capacity of a signalized intersection. This is due to the delays in acceleration at the beginning of a phase and the yellow clearance time at the end of a phase. The values used for capacity of a signalized intersection for planning purposes are listed on the following page. (Ref. 2)

Number of Phases	Capacity
2	1500 vehicles per hour
3	1425 vehicles per hour
4 or more	1375 vehicles per hour

Base Data

As stated above the determination of Level of Service for a signalized intersection is based upon an analysis of turning movements during the PM peak hour. The most comprehensive data was collected in April 1980 by Caltrans. Turning movement counts were collected at all of the intersections that will be analyzed over a 12 hour period. The peak hour began at either 4:30PM or 4:45PM. A summary of the evening peak hour counts for April 1980 is included in the appendix.

Traffic Growth Rate

The growth in traffic projected in the County Transportation Study for the Sebastopol Area was at an annual rate of 2.45%. The actual growth rate of traffic between 1980 and 1982 ranges from an annual rate of 2.9% on Main Street (State Highway 116) north of Bodega Avenue and Sebastopol Avenue to an annual rate of 9.2% on Sebastopol Avenue (State Highway 12) east of Main Street.

In order to determine an estimate of present (1983) traffic the lower growth rate of 2.9% per year will be used. For future growth the projected growth rate of 2.45% per year will be used.

If traffic grows at a higher rate than projected the conditions described herein will occur sooner than anticipated.

PRESENT SITUATION

Main Street, Bodega Avenue, Sebastopol Avenue

The present traffic signal controller is an electro-mechanical pre-timed controller. The timing of the signal is accomplished by one of three dials. Each dial can be set with an individual split and/or cycle length. The selection of the dial in use is accomplished by a time-of-day clock.

The traffic signal has two phases: one for north/south movement and one for east/west movement. There is no separate left turn phase. A driver making a left turn must wait for a gap in the opposing traffic stream. During the peak periods, when there are no gaps, drivers make left turns during the yellow clearance interval. An average of two vehicles per cycle can make this movement.

Based on the 1980 traffic volumes the signalized intersection was operating at Level of Service C or 75% of capacity. Using a growth rate of 2.9% per year the signalized intersection now operates at Level of Service D or 82% of capacity. It is important to note that the demand for southbound left turns exceeds capacity during the evening peak hour.

Using a growth rate of 2.45% per year for the period beyond 1983, the traffic volumes will be such that the intersection will operate at Level of Service E by 1987 and reach capacity by 1992.

Main Street, McKinley Street

The traffic signal controller is a solid state, traffic actuated controller. It is interconnected to the pre-timed controller at Main Street, Bodega Avenue and Sebastopol Avenue. There is no separate left turn phase at this intersection. Unlike the signal at Main Street, Bodega Avenue and Sebastopol Avenue, the pedestrian phase only occurs when actuated. Depending upon the number of pedestrian actuations during the peak hour the intersection will operate between Level of Service B and Level of Service C. The greater the

number of pedestrian cycles utilized during the peak hour the greater the delays to through traffic.

SCENARIO 1: Install Signal at Petaluma Avenue and Sebastopol Avenue.

Petaluma Avenue, Sebastopol Avenue

The new traffic signal at this location will be state-of-the-art, solid state, fully traffic actuated. If Petaluma Avenue remains as a two-way street the new traffic signal will operate as 6 phase, "dual left", split cross street. Eastbound and westbound left turns will have separate phases before the eastbound and westbound through phases. Northbound movements, left and through will be a separate phase from southbound movements. Northbound right turns will be controlled by a yield sign.

With two-way operation on Petaluma Avenue, a signalized intersection will operate at Level of Service B.

Main Street, Bodega Avenue, Sebastopol Avenue

No changes to this intersection are assumed under this scenario.

Main Street, McKinley Street

No changes to this intersection are assumed under this scenario.

SCENARIO 2: Modernize Existing Signals

Main Street, Bodega Avenue, Sebastopol Avenue

A new traffic signal controller at this intersection would be state-of-the-art, solid state, fully traffic actuated. If both Main Street and Bodega Avenue/Sebastopol Avenue remain as two-way streets a new traffic signal will operate as 8 phase "quad left". Separate left turn phases in advance of the associated through phase would be provided. There would be no vehicle conflicts on any traffic phase.

With the existing geometry and estimated 1983 traffic volumes the intersection would operate at the upper threshhold of Level of Service D, near Level of Service E.

There would be an average delay of 35 seconds per vehicle. There is enough storage capacity in the left turn lanes to handle the left turn volumes, however there is not sufficient distance between intersections on Main Street to handle through traffic. A distance of 475 feet would be required to store northbound through traffic. The distance to Burnett Street is 200 feet. A distance of 425 feet would be required to store southbound vehicles. The distance to McKinley Street is 360 feet. Both adjacent intersections would be plugged by traffic on every cycle during the peak hour.

Main Street, McKinley Street

The addition of an actuated left turn phase would add to the convenience of drivers but would not improve the operation of the intersection. The intersection would operate at Level of Service C during the evening peak hour.

Petaluma Avenue, Sebastopol Avenue

This intersection would operate as was described in Scenario 1.

SCENARIO 2a: Balance Movements

A new signal is installed at Petaluma Avenue and Sebastopol Avenue and actuated left turn phases are added to the signal at Main Street, Bodega Avenue, Sebastopol Avenue and at Main Street and McKinley Street.

When this is done there will be some redistribution of traffic. Some drivers now making a southbound to eastbound left turn at Main Street, Bodega Avenue, Sebastopol Avenue will make a left turn at Main Street and McKinley Street and another left turn at Petaluma Avenue and Sebastopol Avenue. Some drivers travelling northbound on Main Street will shift to Petaluma Avenue. The amount of redistribution will be such that the flows will be balanced, i.e.,

northbound left turns equal southbound left turns and northbound through movements equal southbound through movements.

Main Street, Bodega Avenue, Sebastopol Avenue

There will be a decrease in critical volumes at this intersection. The volume to capacity ratio will decrease from 0.89 to 0.81. The intersection will still operate at Level of Service D. The average delay will be about 28 seconds per vehicle.

At a growth rate of 2.45% per year traffic volumes will be such that the volume to capacity ratio will exceed 0.90 in 5 years. A volume to capacity ratio of 0.90 is the threshhold value of Level of Service E.

Because southbound through traffic will not shift, a storage length of 425 feet is still needed for southbound traffic. McKinley Street would be blocked by waiting vehicles.

Main Street, McKinley Street

The shift of traffic, will have very little effect on this intersection. Some northbound through traffic will be shifted to westbound to northbound right turns. Some southbound through traffic will be shifted to southbound left turns. The intersection will continue to operate at Level of Service C during the evening peak hour.

Petaluma Avenue, Sebastopol Avenue

The shift of traffic will add traffic to this intersection, mainly northbound through traffic. The intersection will operate at Level of Service C during the evening peak hour.

SCENARIO 3: Remove Parking - Main Street

There are only two ways to reduce lane volumes. One is to reduce volumes by diverting traffic. The other is to increase the number of lanes. The number

of through traffic lanes on Main Street can be increased by removing parking.

Main Street, Bodega Avenue, Sebastopol Avenue

The operation of this intersection would be improved to the upper threshhold of Level of Service B, near Level of Service C with the prohibition of parking on both sides of Main Street. The prohibition would only have to be between Burnett Street and McKinley Street to be effective. At an annual growth rate of 2.45% traffic lane volumes would reach the present level by 1994.

Removal of parking on only the west side of Main Street would not improve the operation of the intersection. The intersection would operate at Level of Service D, near Level of Service E, as is the case with parking permitted on both sides of the street.

Removal of parking on only the east side of Main Street would improve the operation of the intersection. The intersection would operate at the upper threshhold of Level of Service C, near Level of Service D. At an annual growth rate of 2.45% traffic lane volumes would reach the present level by 1988.

Main Street, McKinley Street

Since parking would not have to be removed north of McKinley Street the intersection would operate the same as in Scenario 2.

Petaluma Avenue, Sebastopol Avenue

This intersection would operate as in Scenario 1.

SCENARIO 4: Prohibit Left Turns Northbound and Southbound. No additional signals.

One way to reduce critical volumes is to eliminate movements. In this scenario it is assumed that a signal has been installed at Petaluma Avenue and Sebastopol Avenue and that the signal at Main Street and McKinley Street has

The situation could be improved slightly by the addition of a second lane southbound. The intersection would then operate at the lower threshhold of Level of Service D, just above Level of Service C.

SCENARIO 5: North-South One-Way Couplet

With the north-south couplet all southbound traffic will use Main Street. There will be two southbound lanes at McKinley Street increasing to three southbound lanes at Bodega Avenue, Sebastopol Avenue. At Burnett Street there will be two southbound through lanes and one southbound left turn lane.

All northbound traffic will use Petaluma Avenue. There will be two northbound lanes. There will be an additional right turn lane at Sebastopol Avenue.

Main Street north of McKinley Street will be two-way operation. McKinley Street east of Main Street will have two lanes one for right turns and one for left turns.

Main Street, Bodega Avenue, Sebastopol Avenue

The operation of the intersection will improve to Level of Service C, just above the threshhold of Level of Service B. Delays will be reduced to an .E

average of 23 seconds per vehicle. At a growth rate of 2.45% per year traffic will not reach present levels until 1992.

Main Street, McKinley Street

The operation of the intersection will improve to Level of Service C.

Petaluma Avenue, Sebastopol Avenue

The intersection will operate at Level of Service C with the additional traffic diverted from Main Street. This is one level lower than would be the case if Petaluma Avenue were two-way operation. At a growth rate of 2.45% per

year the intersection would reach the threshhold between Level of Service D and Level of Service E by 1989.

SCENARIO 5a: North-South One-Way Couplet (Main Street Northbound, Petaluma Avenue Southbound)

This is a reverse one-way couplet. Northbound traffic will use Main Street and southbound traffic will use Petaluma Avenue. A traffic signal is needed at Main Street, Petaluma Avenue and Gravenstein Highway South.

Main Street, Petaluma Avenue, Gravenstein Highway South

A traffic signal at this location would operate at Level of Service E with the present geometry, i.e., 3 lanes on Gravenstein Highway South. If Gravenstein Highway south were widened to 4 lanes south of the intersection the service level could be improved to Level of Service B. The widening would have to extend for a sufficient length to allow southbound traffic to merge into one lane.

Main Street, Bodega Avenue, Sebastopol Avenue

The intersection would operate at Level of Service B during the peak hour.

The reason for the improvement is that the eastbound to northbound left turns that would have to be accommodated in this scenario are less than the westbound to southbound left turns that are handled under Scenario 5, Main Street southbound.

Main Street, McKinley Street

The intersection will operate at Level of Service D during the peak hour. If Main Street is re-marked to provide two lanes in each direction, the intersection will operate at Level of Service A.

Petaluma Avenue, Sebastopol Avenue

The intersection will fail during the peak hour. The reason for the failure is that the northbound to eastbound right turn, which was handled as a free right turn under Scenario 5, now becomes an eastbound through movement under Scenario 5a. The intersection could not handle the projected traffic without an extensive street widening project.

SCENARIO 6: Both Couplets

With both couplets north-south traffic will use the routes as described in Scenario 5. East-west traffic will also be split. Eastbound traffic will use South High Street, Burnett Street and Petaluma Avenue. Westbound traffic will use Sebastopol Avenue and Bodega Avenue.

New traffic signals will be needed at South Main Street and Burnett Street and at Petaluma Avenue and Burnett Street.

Both Burnett Street and South High Street (between Bodega Avenue and Burnett Street) would have to be reconstructed to handle increased traffic, especially truck traffic.

Main Street, Bodega Avenue, Sebastopol Avenue

The operation of the intersection will improve to Level of Service A. Delays will be reduced to an average of less than 16 seconds per vehicle. At a growth rate of 2.45% per year traffic will not reach present levels until 2004.

Main Street/McKinley Street

The operation of the intersection will be the same as with only the north-south couplet. The intersection will operate at Level of Service B or C depending upon the number of pedestrian actuated phases during the peak hour. At a growth rate of 2.45% per year the intersection would reach the threshhold between Level of Service D and Level of Service E by 199B.

Petaluma Avenue, Sebastopol Avenue

The operation of this intersection will be improved to Level of Service B. This is the same level that would be the case if Petaluma Avenue were a two-way operation. At a growth rate of 2.45% per year the intersection would reach the threshhold between Level of Service D and Level of Service E by 1997.

South Main, Burnett Street

A new signal would be needed at this intersection. At 1983 traffic volumes the intersection would operate at Level of Service A. At a growth of 2.45% per year the intersection would not reach the threshhold between Level of Service D and Level of Service E until 2005.

Petaluma Avenue, Burnett Street

A new signal would be needed at this intersection. At 1983 traffic volumes the intersection would operate at Level of Service A. At a growth rate of 2.45% per year the intersection would not reach the threshhold between Level of Service D and Level of Service E until 2007.

(Revised 12/27/83)

REFERENCES

1. Highway Research Board, Highway Capacity Manaual, Special Report #87, 1965.

2. Transportation Research Board, Interim Materials on Highway Capacity, Circular #212, January 19BO.

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SUMMARY OF TRAFFIC SOLUTIONS

TRAFFIC SOLUTION	C V	v/c	LOS	Yrs until v/c=.90
PRESENT SITUATION				
Main/Bodega/Sebastopol	1224	.82	0	
Main/McKinley	1009-1136	.67-.76	B-C	
Petaluma/Sebastopol	not signalized			
SCENARIO 1: Signal at Petaluma/Sebastopol				
Main/Bodega/Sebastopol	1224	.82	D	
Main/McKinley	1009-1136	.67-.76	B-C	
Petaluma/Sebastopol	922	.67	B	13
SCENARIO 2: Modernize Signals				
Main/Bodega/Sebastopol	1224	.89	0	1
Main/McKinley	1008-1170	.71-.82	C-0	10
Petaluma/Sebastopol	922	.67	B	13
SCENARIO 2a: Balance Movements				
Main/Bodega/Sebastopol	1114	.81	0	5
Main/McKinley	996-1158	.70	C-0	11
Petaluma/Sebastopol	1032	.75	C	8
SCENARIO 3: Remove Parking Main St				
Main/Bodega/Sebastopol	960	.70	B	11
Main/McKinley	1008-1170	.71-.82	C-0	10
Petaluma/Sebastopol	922	.67	B	13
SCENARIO 3a: Remove Parking West side Main St				
Main/Bodega/Sebastopol	1224	.89	0	1
Main/McKinley	1008-1170	.71-.82	C-0	10
Petaluma/Sebastopol	922	.67	B	13
SCENARIO 3b: Remove Parking East side Main St				
Main/Bodega/Sebastopol	1114	.81	0	5
Main/McKinley	1008-1170	.71-.82	C-0	10
Petaluma/Sebastopol	922	.67	B	13
SCENARIO 4: Prohibit Nb, Sb Left Turns at Main/Bodega/Sebastopol				
Main/Bodega/Sebastopol	1285	.93	E	0
Main/McKinley	1277-1439	.90-1.01	0-E	1
Petaluma/Sebastopol	1291	.94	E	0
SCENARIO 4a: Same as 4; add lanes				
Main/Bodega/Sebastopol	966	.70	C	11
Main/McKinley	1133-1295	.80-.91	0-E	6
Petaluma/Sebastopol	1108	.81	0	5
SCENARIO 5: North-South One Way Couplet				
Main/Bodega/Sebastopol	1022	.72	C	10
Main/McKinley	951	.63	B	15
Petaluma/Sebastopol	1112	.78	C	6

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SUMMARY OF TRAFFIC SOLUTIONS (continued)

TRAFFIC SOLUTION	C V	v/c	LOS	Yrs until v/c=.90
SCENARIO 5a: North-South One-Way Couplet Main St Nb, Petaluma Ave Sb				
Main/Petaluma/Gravenstein Hwy So	1367	.91	E	0
Main/Bodega/Sebastopol	941	.66	B	13
Main/McKinley	1269	.B5	D	3
Petaluma/Sebastopol	1690	1.19	Fail	0
SCENARIO 5b: North-South One-Way Couplet Main St Nb, Petaluma Ave Sb Add Lanes				
Main/Petaluma/Gravenstein Hwy So	927	.62	B	16
Main/Bodega/Sebastopol	941	.66	B	13
Main/McKinley	BB1	.59	A	1B
Petaluma/Sebastopol	1497	1.05	Fail	0
SCENARIO 6: Both Couplets				
Main/Bodega/Sebastopol	B13	.54	A	21
Main/McKinley	951	.63	B	15
Petaluma/Sebastopol	971	.65	B	14
So Main/Burnett	798	.53	A	22
Petaluma/Burnett	766	.51	A	24

C V = Sum of Critical Volumes
v/c = Volume to capacity ratio
LOS = Level of Service

(Revised 12/27/B3)

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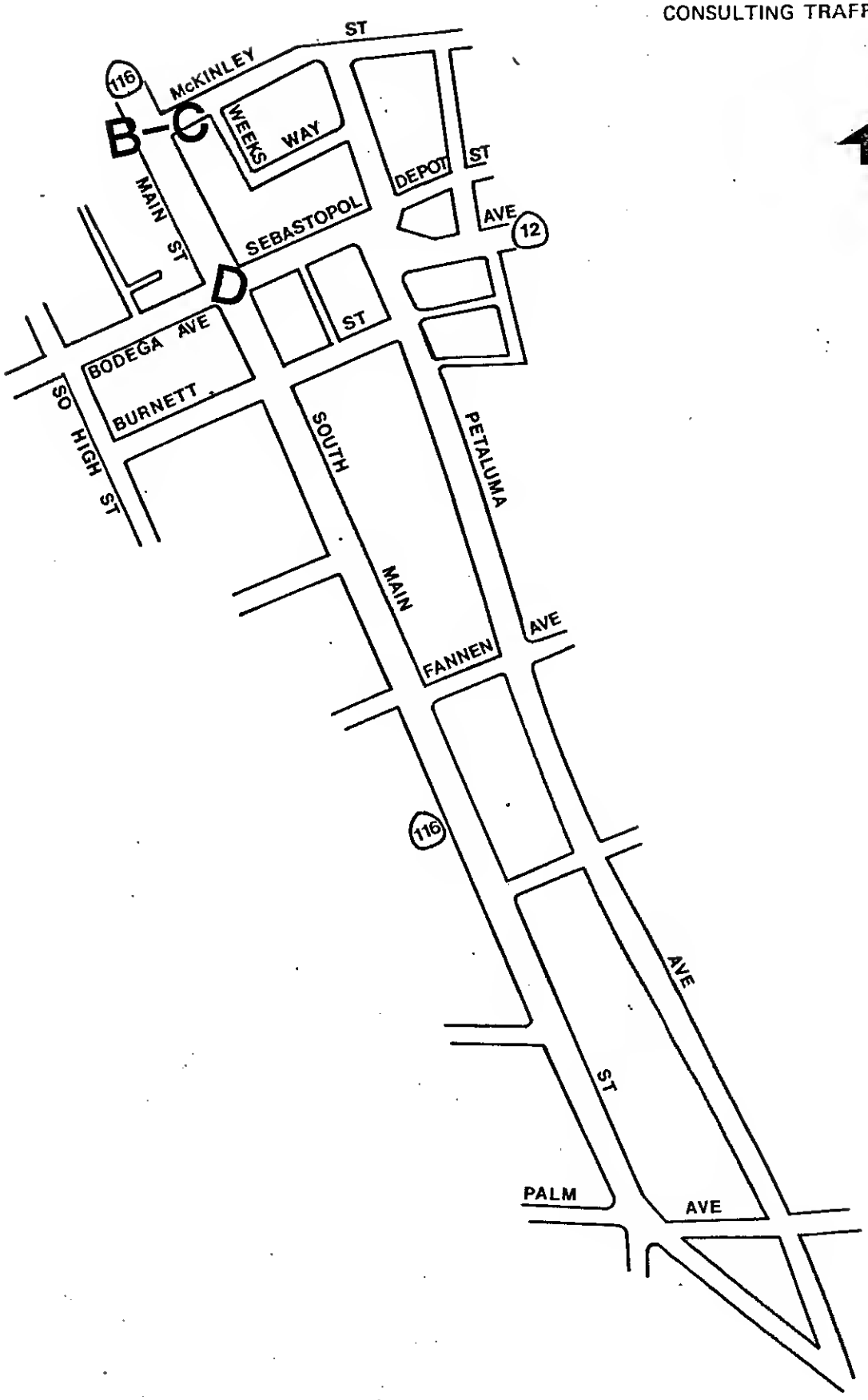

Present Situation

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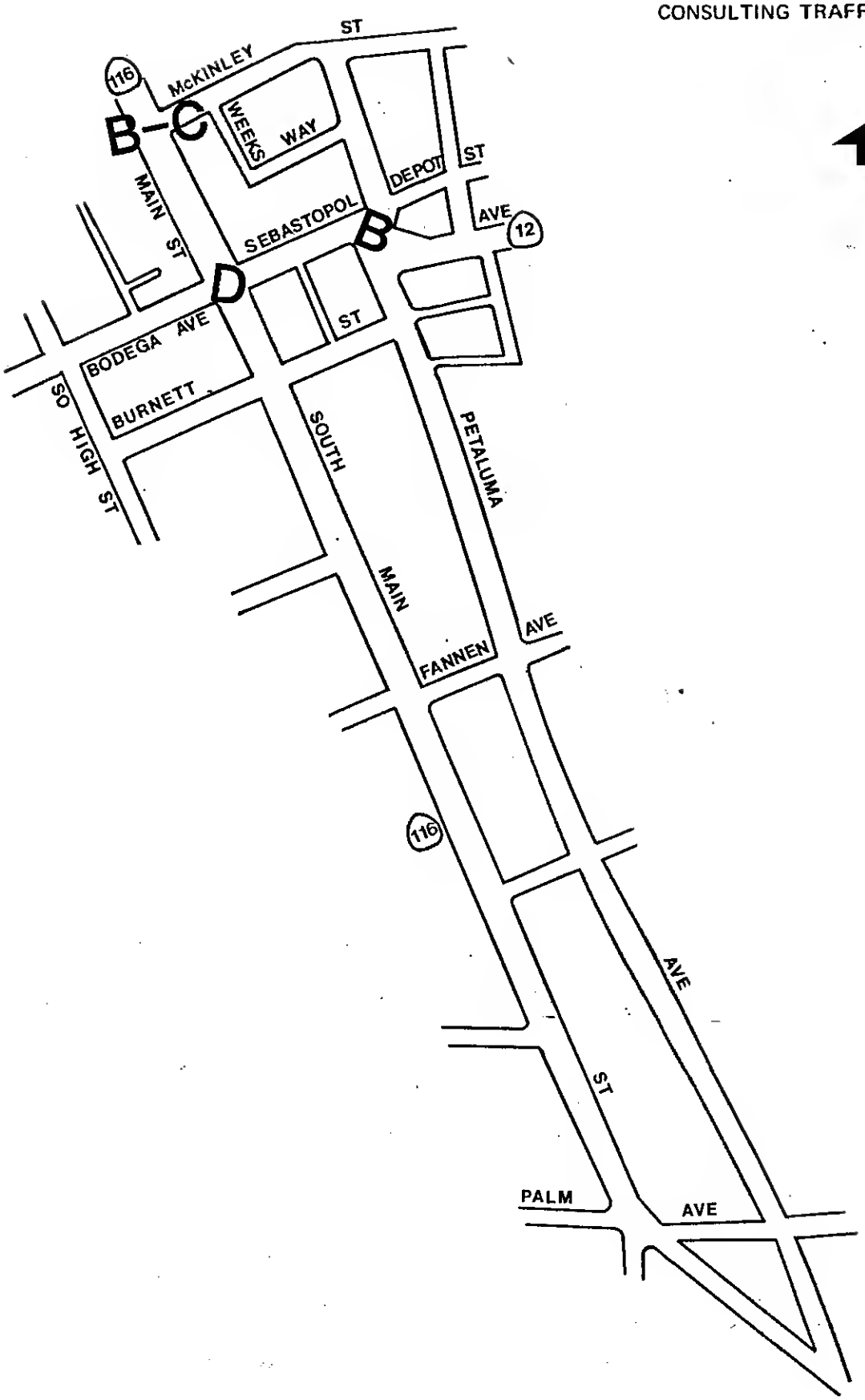

SCENARIO 1

New signal at Petaluma Avenue
and Sebastopol Avenue

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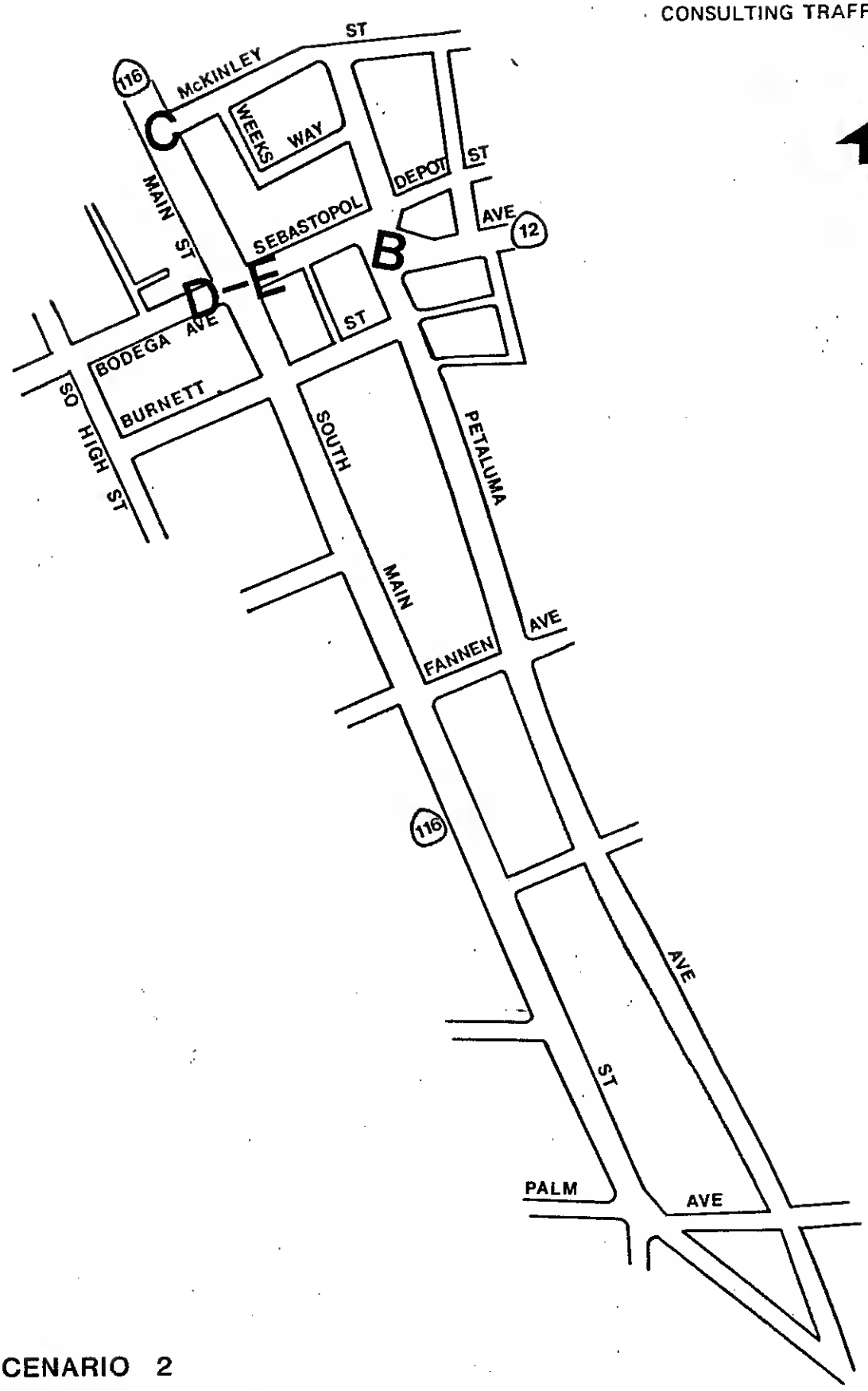

SCENARIO 2

Modernize Existing Signal

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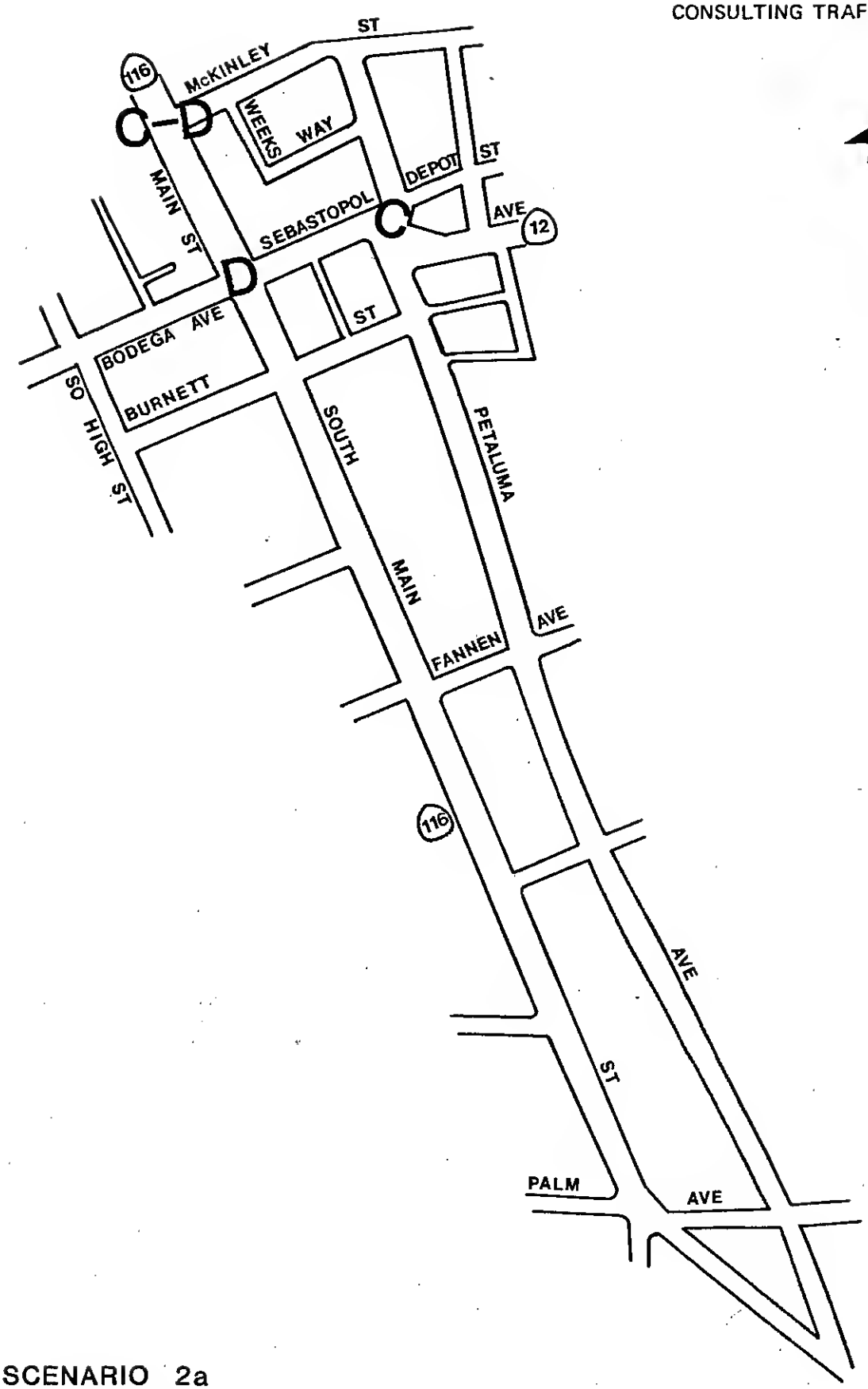

SCENARIO 2a

Balance Movements

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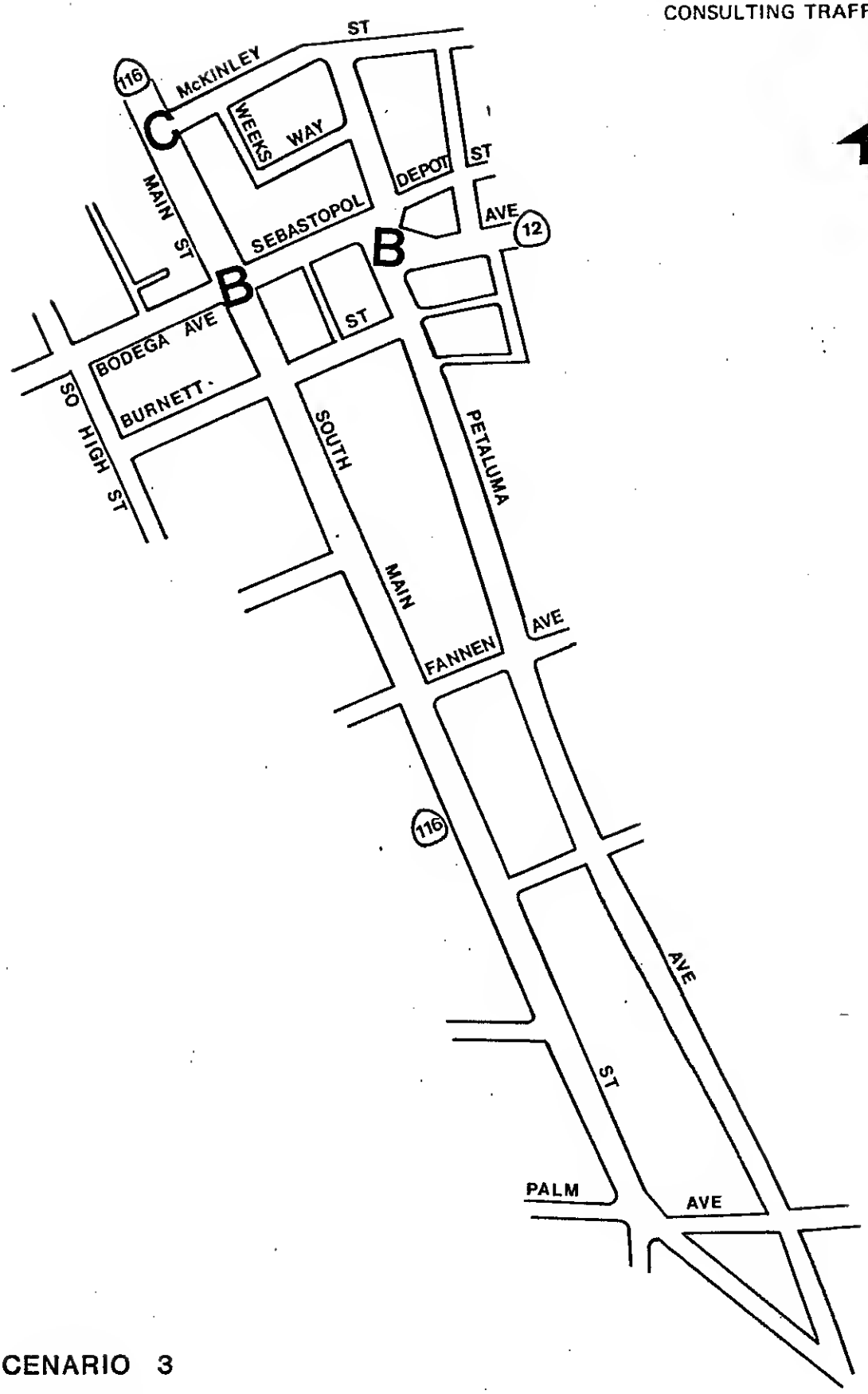

SCENARIO 3

Eliminate Parking Both Sides –Main Street

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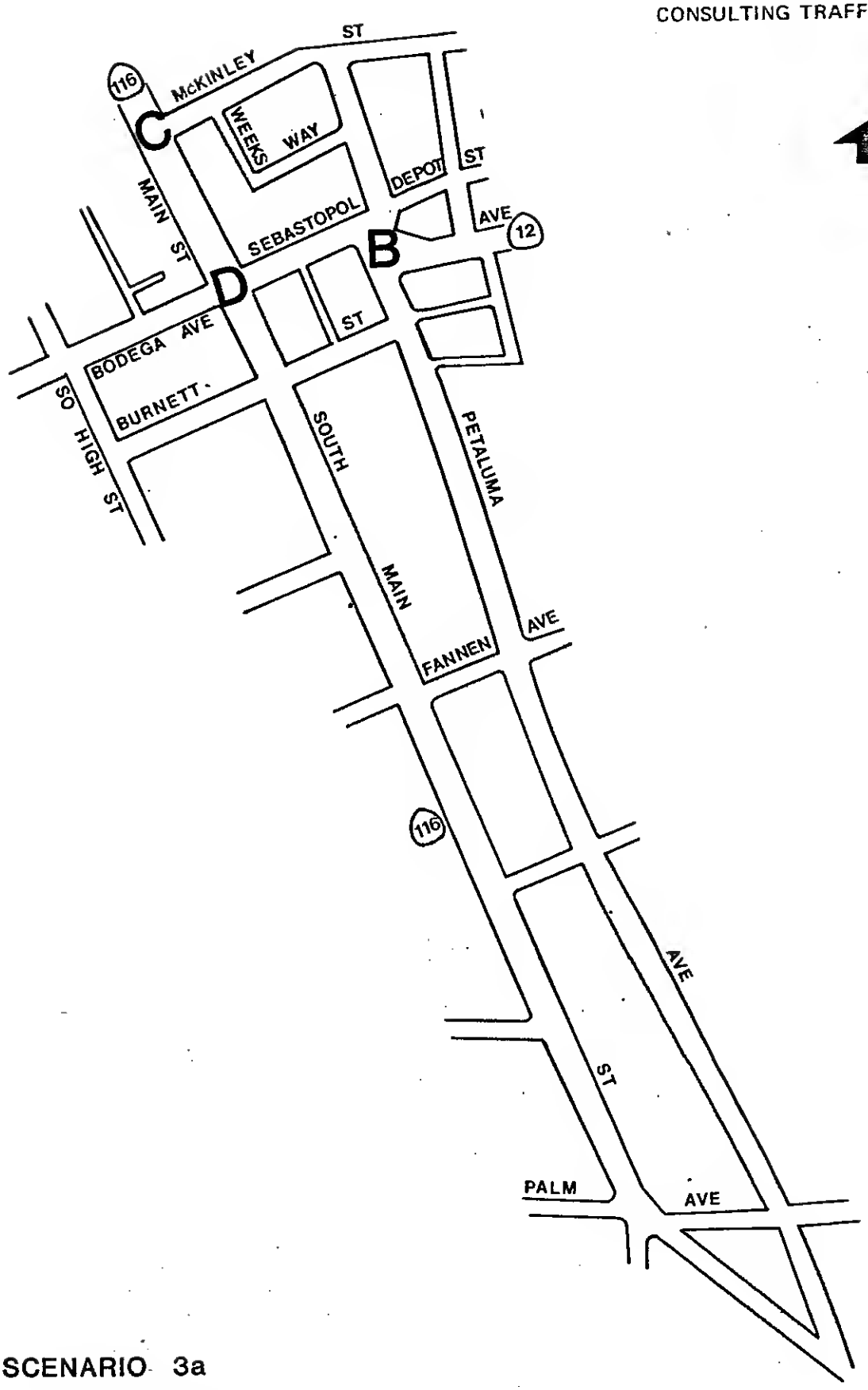

SCENARIO 3a

Eliminate Parking West Side – Main Street

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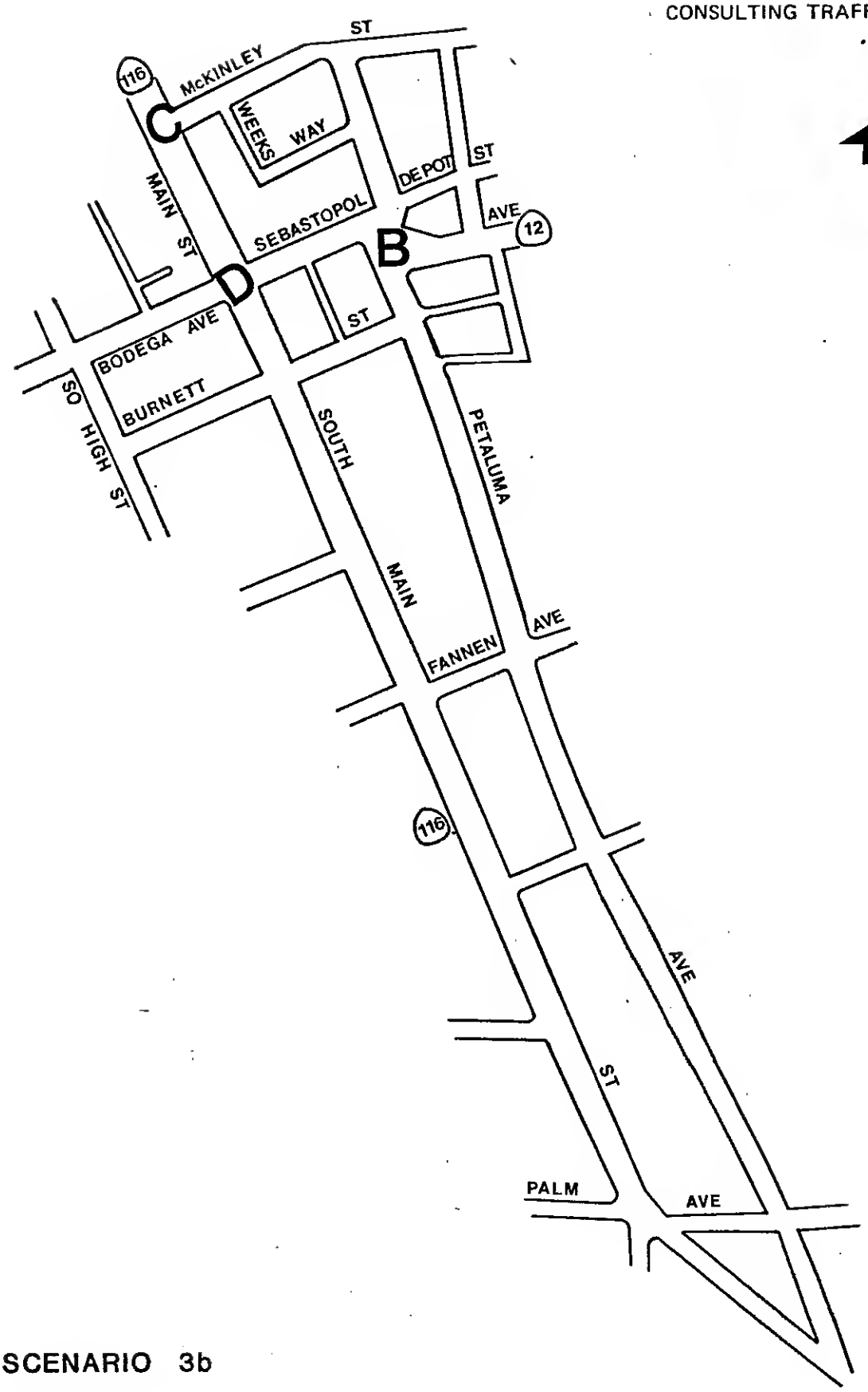

SCENARIO 3b

Eliminate Parking East Side – Main Street

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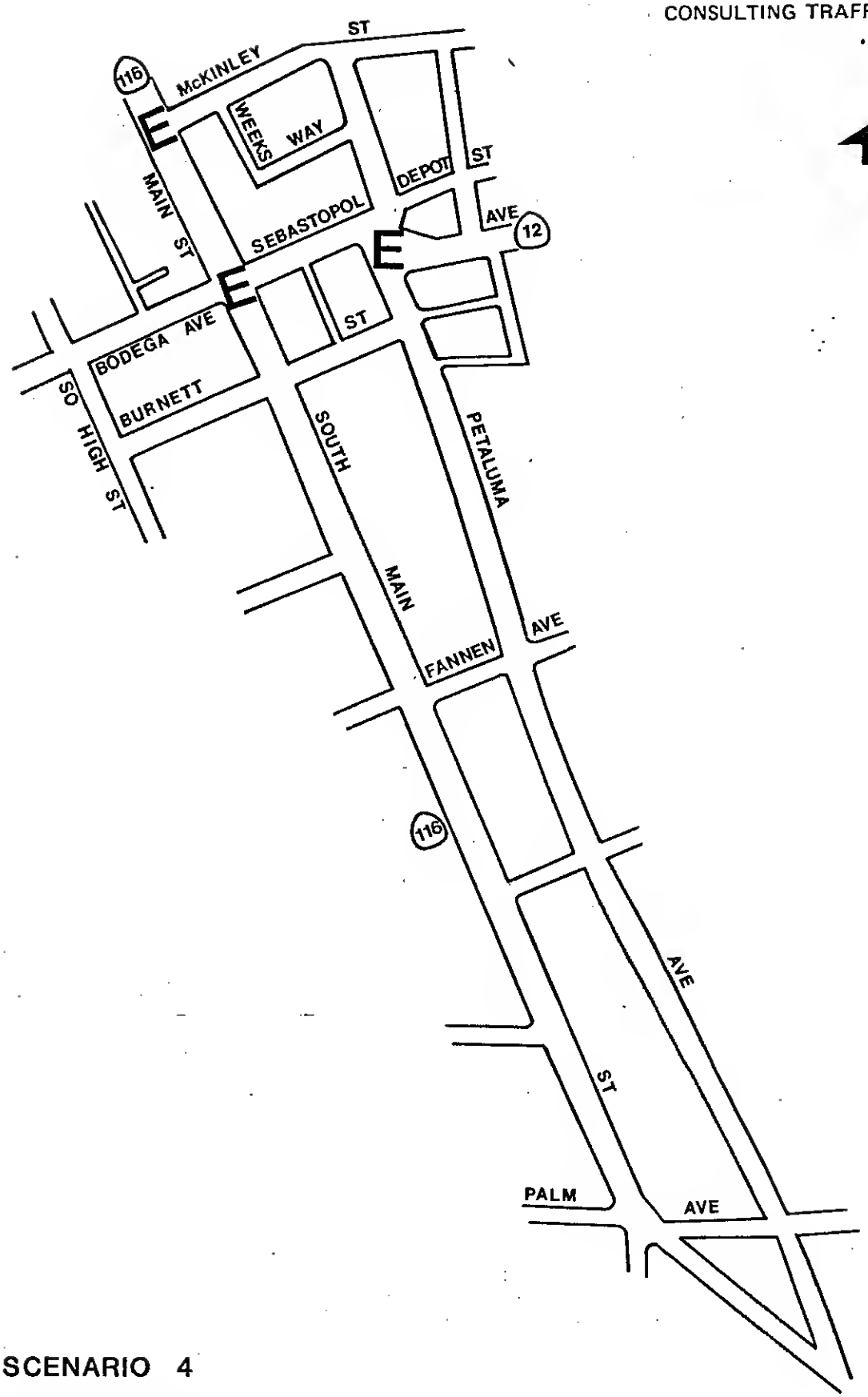

SCENARIO 4

Prohibit Northbound and Southbound Left Turns at Main/Bodega/Sebastopol

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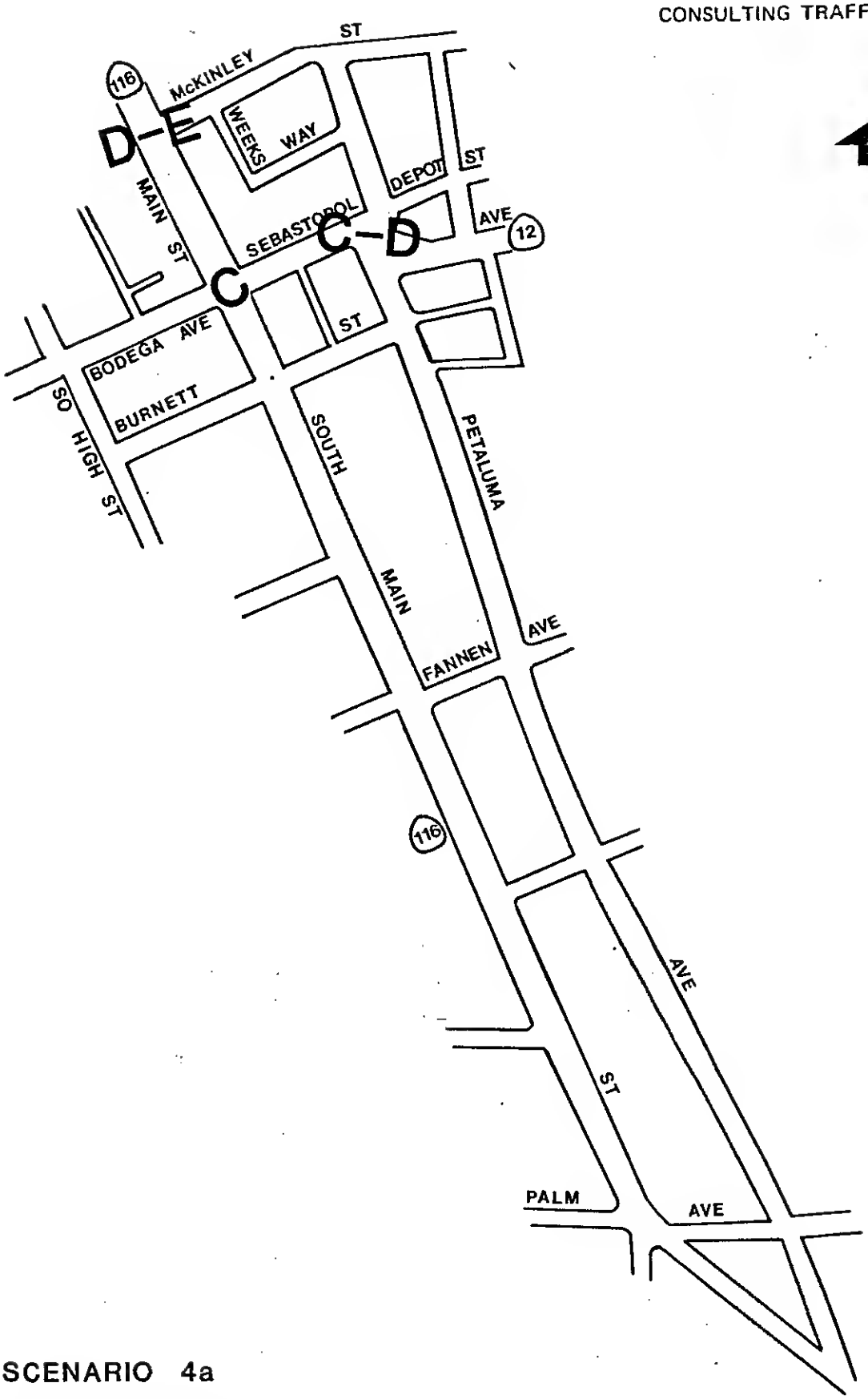

SCENARIO 4a

Prohibit Northbound and Southbound Left Turns at Main/Bodega/Sebastopol
Add Lanes

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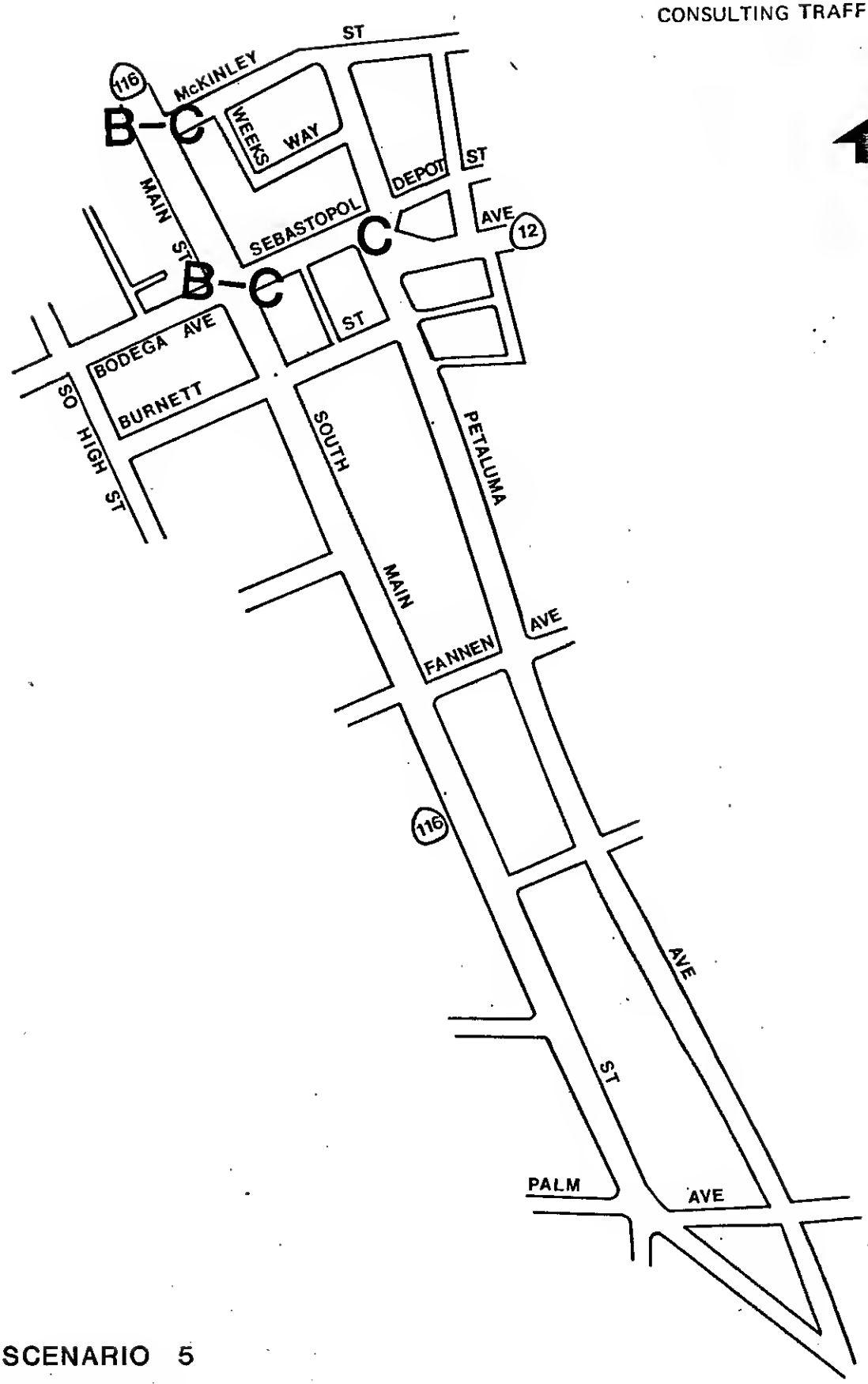

SCENARIO 5

North-South One-Way Couplet

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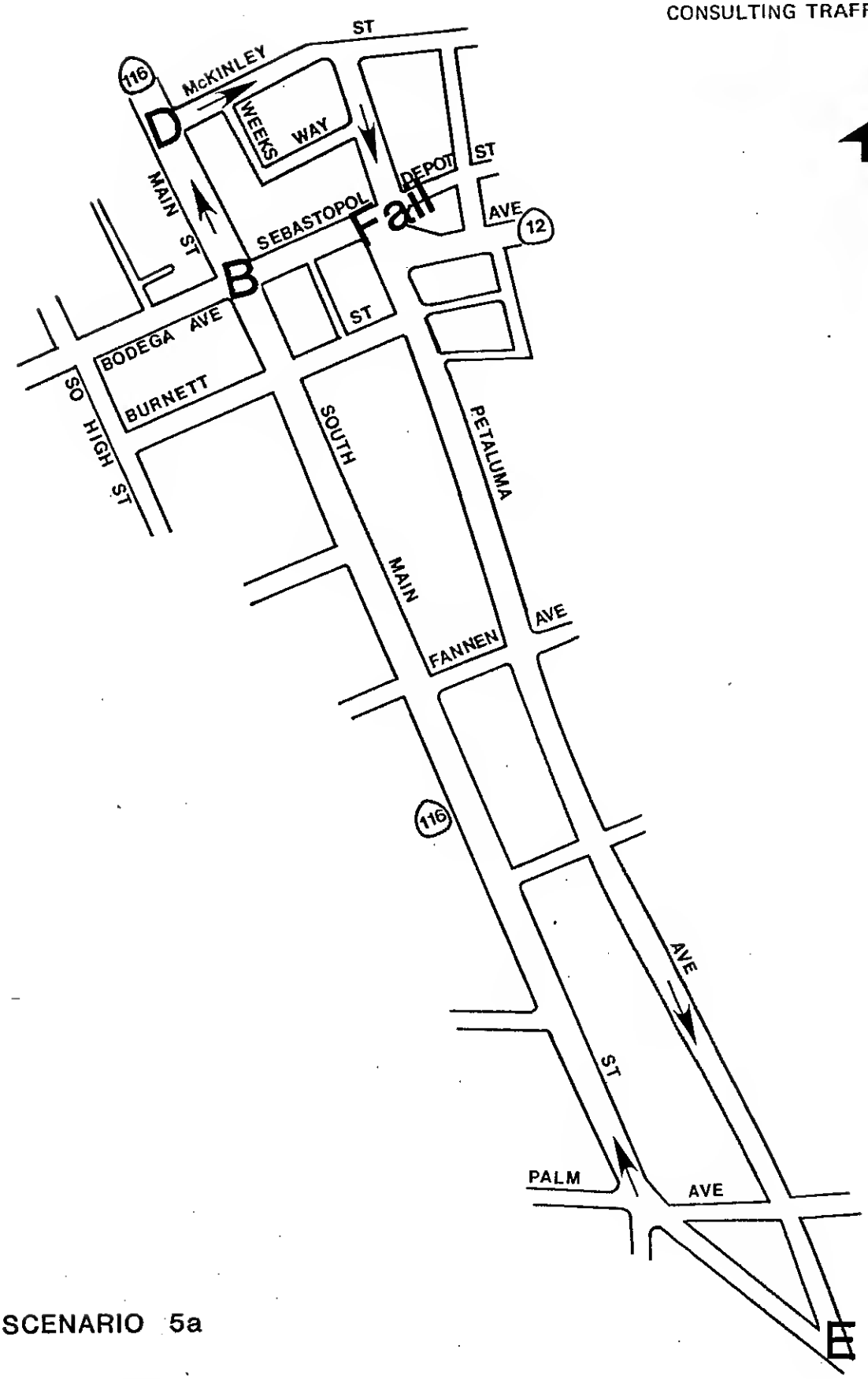

SCENARIO 5a

North-South One-Way Couplet
Main Street Nb
Petaluma Avenue Sb

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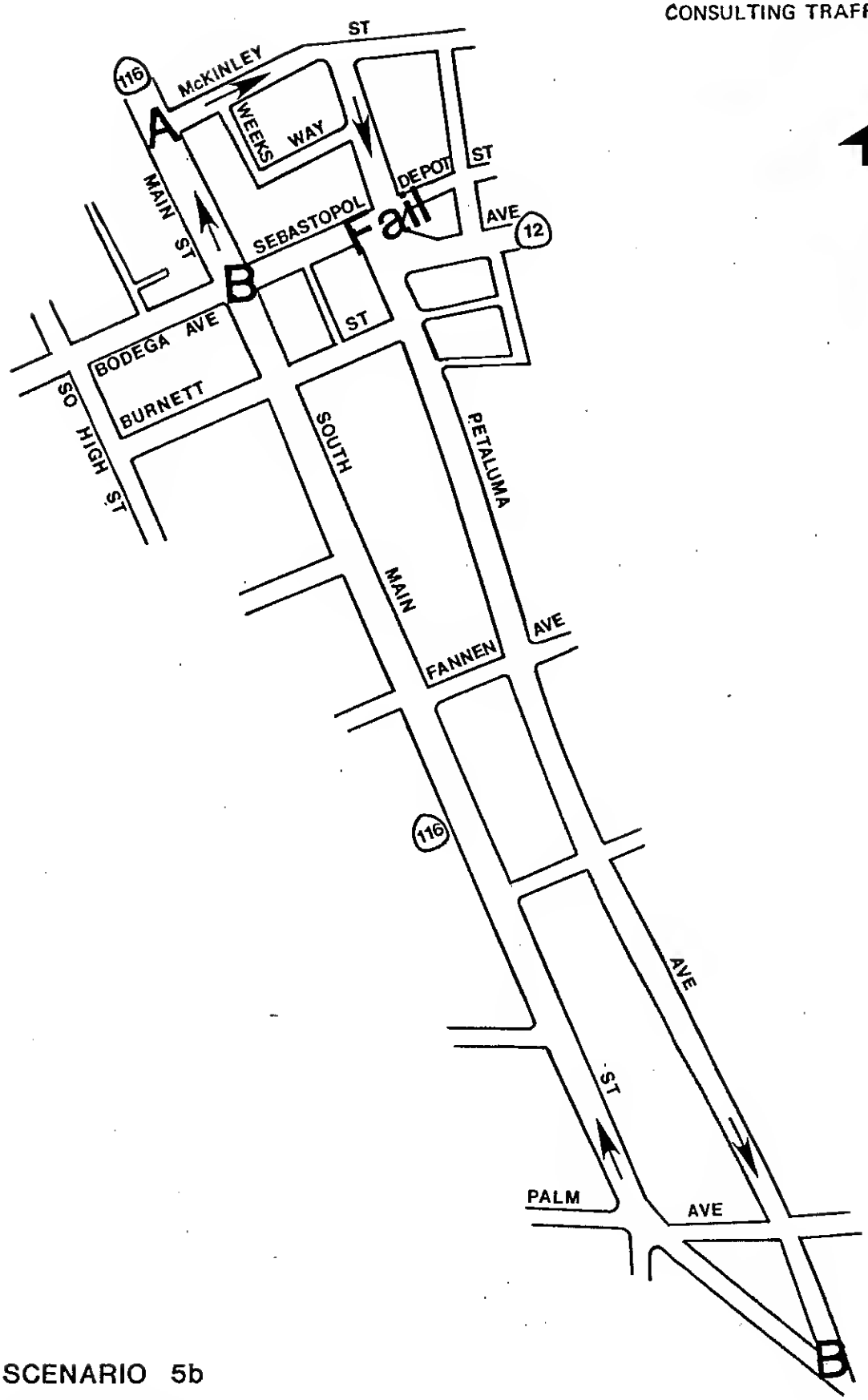

SCENARIO 5b

North-South One-Way Couplet
Main Street Nb
Petaluma Avenue Sb
Add Lane

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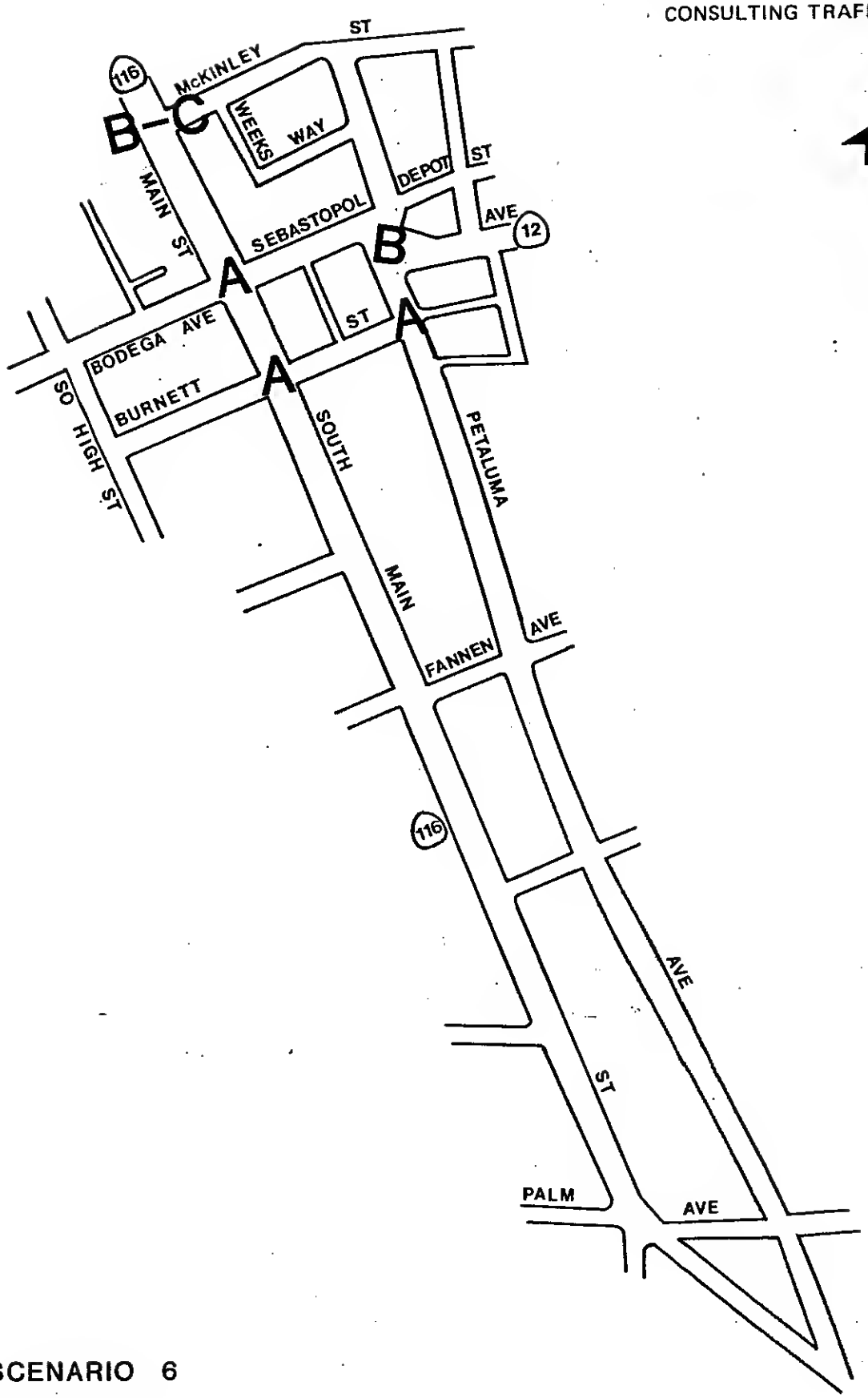

SCENARIO 6

Both Couplets

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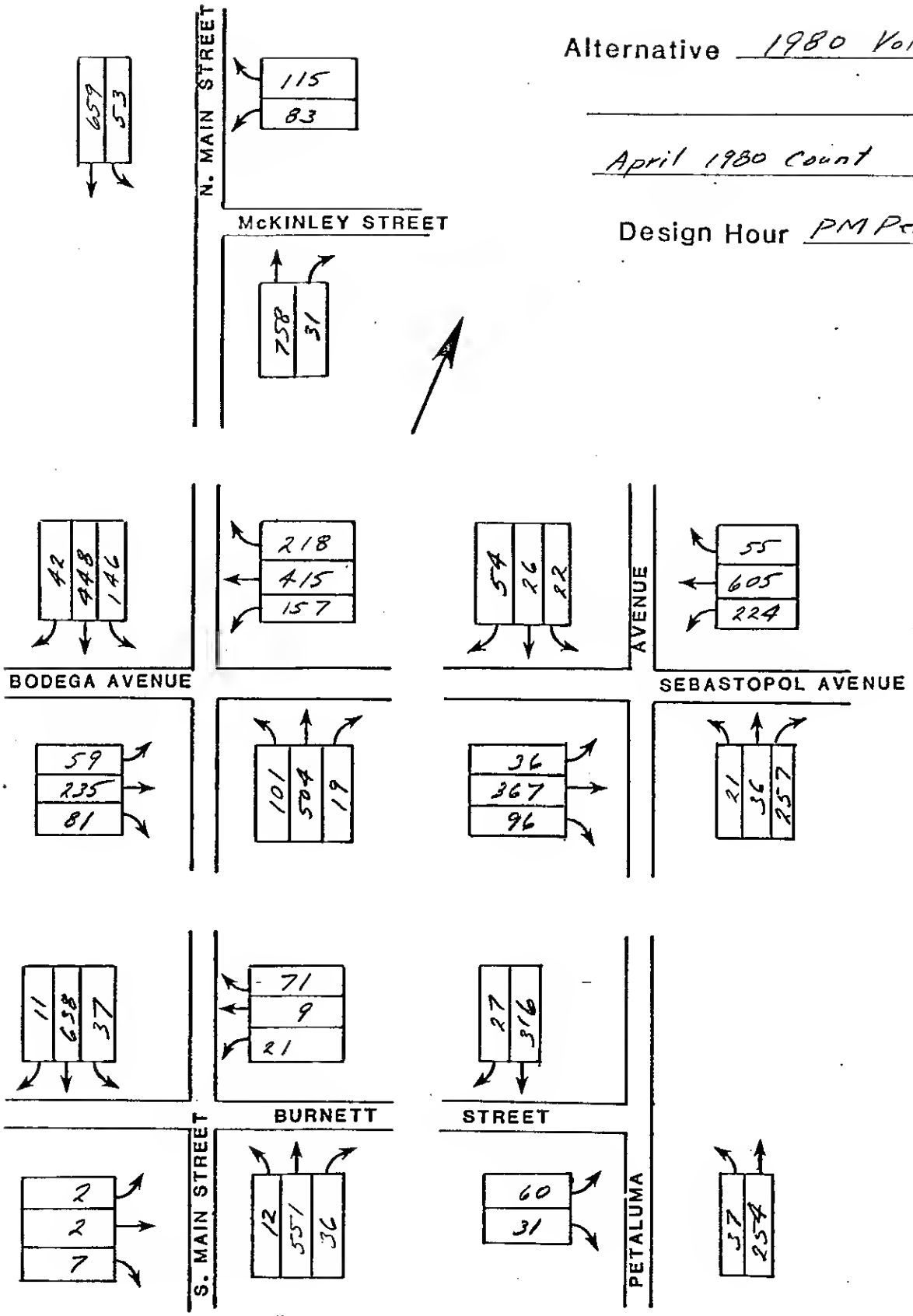
APPENDIX

Alternative 1980 Volumes

April 1980 Count

Design Hour PM Peak



Critical Movement Analysis: PLANNING
Calculation Form 1

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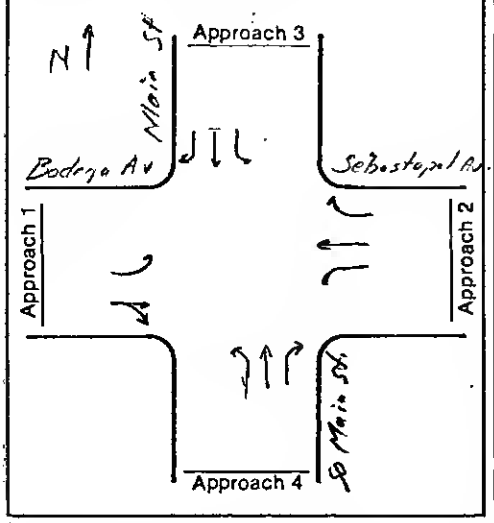
Intersection Main St & Sebastopol Av & Bodega Av **Design Hour** PM Peak

Problem Statement Existing Conditions 1980 Volumes

Step 1. Identify Lane Geometry



Step 4. Left Turn Check

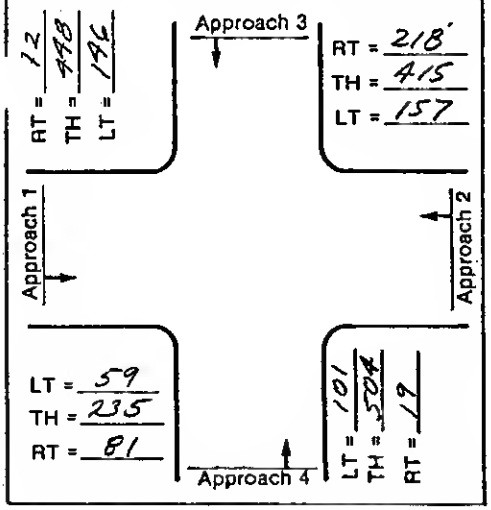
60 sec cycle

	Approach 1	Approach 2	Approach 3	Approach 4
a. Number of change intervals per hour	60	60	60	60
b. Left turn capacity on change interval, in vph	120	120	120	120
c. G/C Ratio	.50	.50	.50	.50
d. Opposing volume in vph	633	316	523	490
e. Left turn capacity on green, in vph	0	284	77	110
f. Left turn capacity in vph (b + e)	120	404	197	230
g. Left turn volume in vph	59	157	146	101
h. Is volume > capacity (g > f)?	No	No	No	No

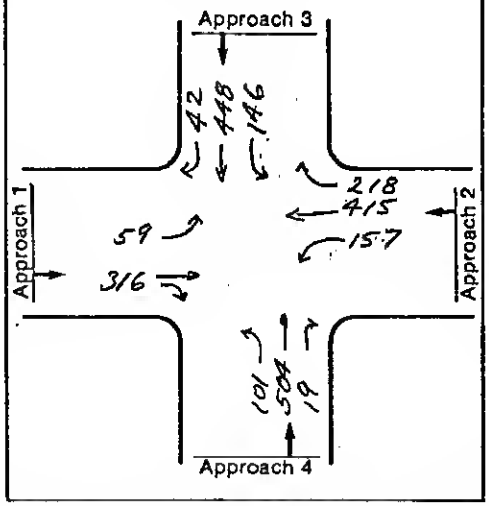
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
2φ			

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

59 + 415 + 146 + 504

= 1124 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

v/c : 0.75 C

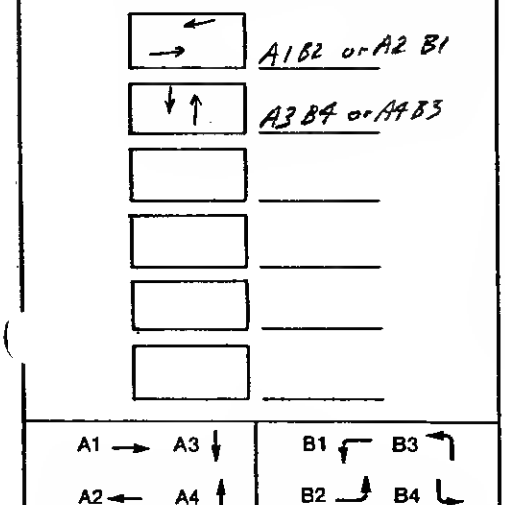
Step 9. Recalculate

Geometric Change _____

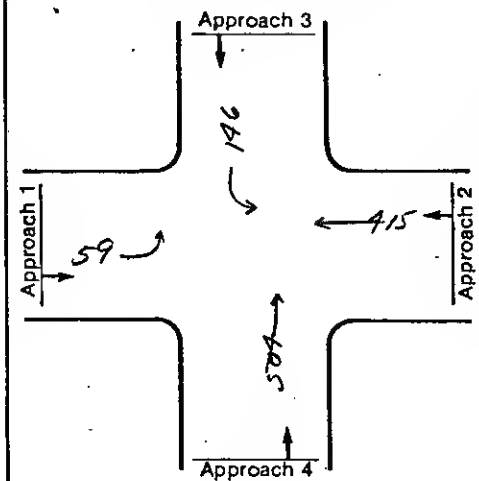
Signal Change _____

Volume Change _____

Step 3. Identify Phasing 2φ



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

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Table 6. Level of Service Ranges

PLANNING Applications (in vph)

Level of Service	Maximum Sum of Critical Volumes: Two Phase	Three Phase	Four or more Phases
A	900	855	825
B	1050	1000	965
C	1200	1140	1100
D	1350	1275	1225
E	1500	1425	1375
F	---------not applicable---------		

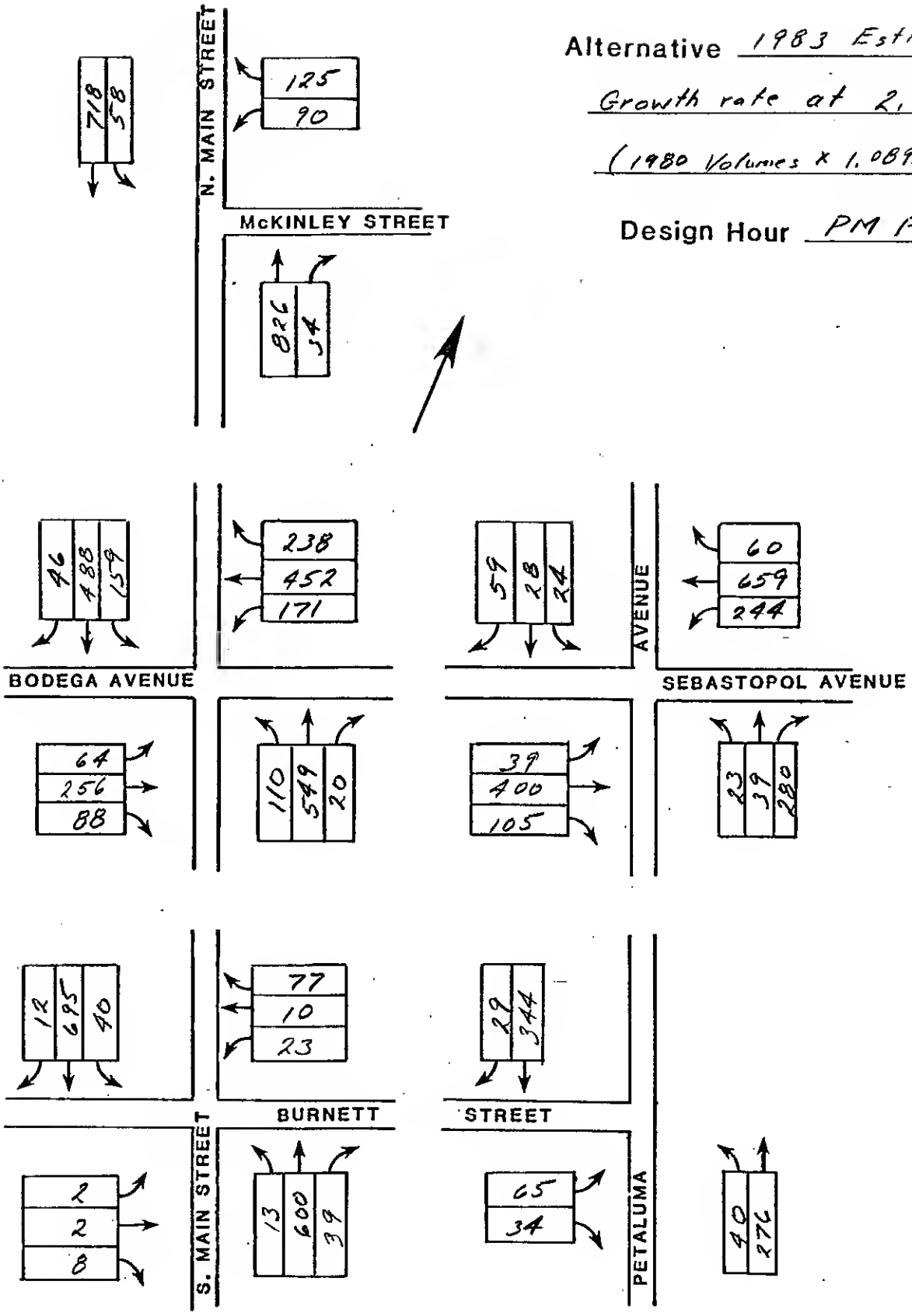
Source: TRB Circular 212

Alternative 1983 Estimated Volumes

Growth rate at 2.9% per year

(1980 Volumes x 1.0895)

Design Hour PM Peak

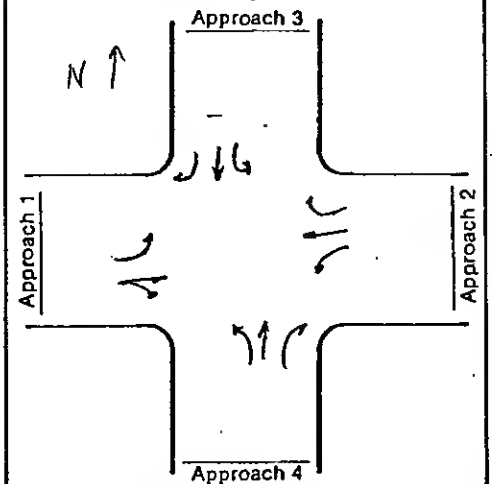


Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection Main. St & Sebastopol Ave & Badega Ave **Design Hour** PM Peak

Problem Statement Existing Conditions 1983 Estimated Volumes

Step 1. Identify Lane Geometry



Step 4. Left Turn Check

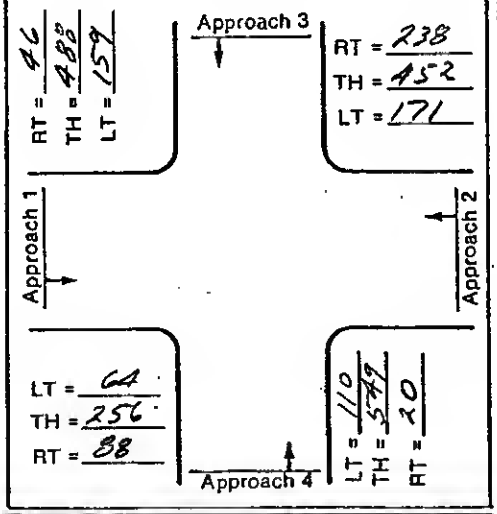
60 sec cycle

	Approach 1	Approach 2	Approach 3	Approach 4
a. Number of change intervals per hour	60	60	60	60
b. Left turn capacity on change interval, in vph	120	120	120	120
c. G/C Ratio	.5	.5	.5	.5
d. Opposing volume in vph	690	344	569	534
e. Left turn capacity on green, in vph	0	256	31	66
f. Left turn capacity in vph (b + e)	120	376	151	186
g. Left turn volume in vph	64	171	159	110
h. Is volume > capacity (g > f)?	No	No	Yes	No

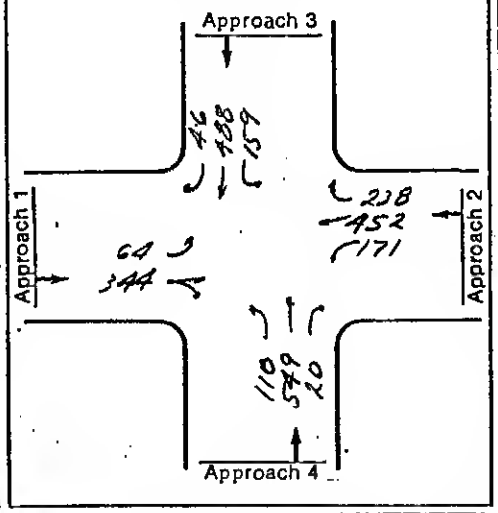
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
2φ			

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

64 + 452 + 159 + 549

= 1224 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

v/c = 0.82 D

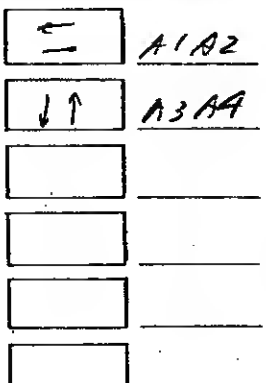
Step 9. Recalculate

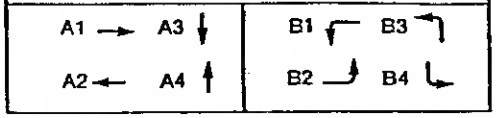
Geometric Change _____

Signal Change _____

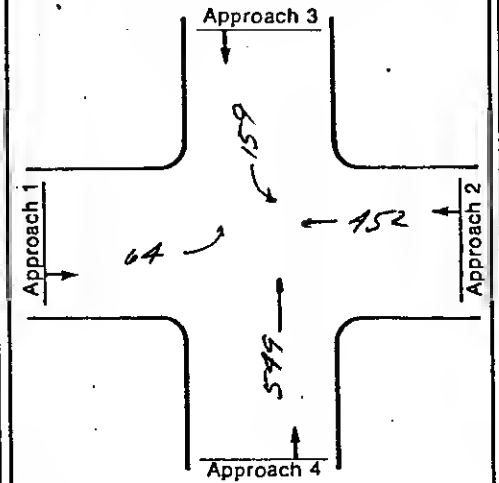
Volume Change _____

Step 3. Identify Phasing 2φ





Step 6a. Critical Volumes, in vph (two phase signal)



Comments

56 Left turns exceed capacity

Table 6. Level of Service Ranges

PLANNING Applications (in vph)

Level of Service	Maximum Sum of Critical Volumes: Two Phase	Three Phase	Four or more Phases
A	900	855	825
B	1050	1000	965
C	1200	1140	1100
D	1350	1275	1225
E	1500	1425	1375
F	---------not applicable---------		

Reference: TRB Circular 212, *Interim Materials on Highway Capacity*, 1980

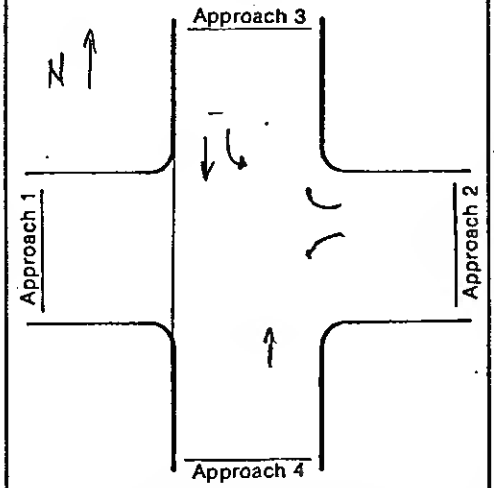
WALTER W. LAABS JR., P.E.
CONSULTING TRAFFIC ENGINEER

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection Main Street & McKinley St **Design Hour** P.M Peak

Problem Statement Existing Conditions 1983 Estimated Volumes

Step 1. Identify Lane Geometry



Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

Actuated

Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Pedestrian Minimum across Main Street.

$7 + \frac{50}{4} - 3 = 16.5$ sec

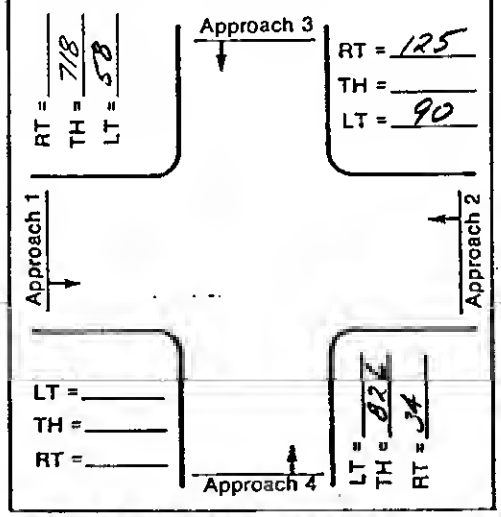
or 7 veh/cycle

100 second cycle

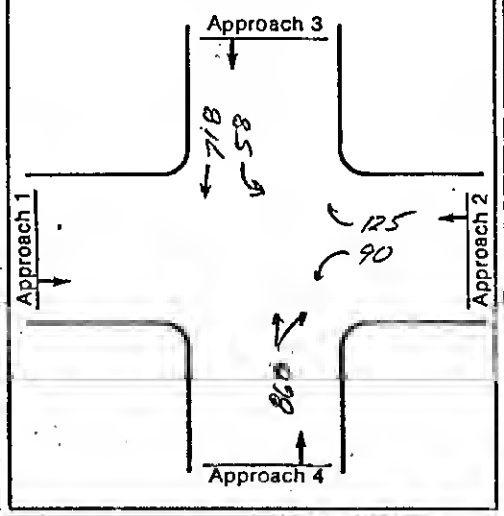
36 cycles per hour

Ped equivalent = 252 veh/hr

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

or 252 (Ped)

$\frac{58}{.76} + \frac{826}{1136} + \frac{125}{.67} + \frac{\quad}{\text{or}} = 1009$ vph

v/c: .76 .67

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

B-C

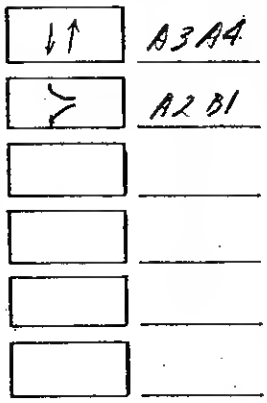
Step 9. Recalculate

Geometric Change _____

Signal Change _____

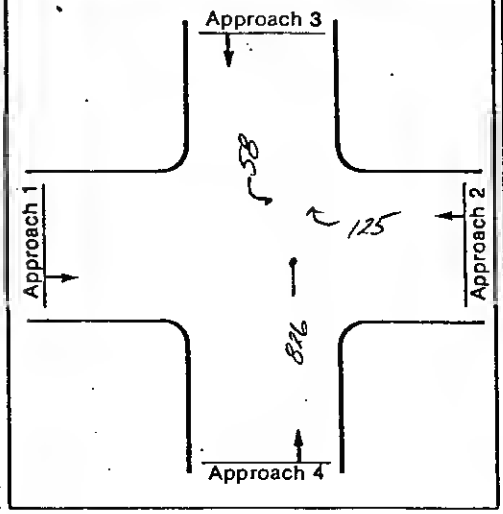
Volume Change _____

Step 3. Identify Phasing



A1 →	A3 ↓	B1 ←	B3 ↑
A2 ←	A4 ↑	B2 →	B4 ↓

Step 6a. Critical Volumes, in vph (two phase signal)



Comments

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Table 6. Level of Service Ranges

PLANNING Applications (in vph)

Level of Service	Maximum Sum of Critical Volumes: Two Phase	Three Phase	Four or more Phases
A	900	855	825
B	1050	1000	965
C	1200	1140	1100
D	1350	1275	1225
E	1500	1425	1375
F	---------not applicable---------		

Reference: TRB Circular 212, *Interim Materials on Highway Capacity*, 1980

WALTER W. LAABS JR., P.E.
CONSULTING TRAFFIC ENGINEER

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(6 Phase Dual Left Split Cross Street Signal)

Intersection:

A: Sebastopol Avenue	Eb		D	
B: Sebastopol Avenue	Wb	A		B
C: Petaluma Avenue	Nb		C	
D: Petaluma Avenue	Sb			

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (1)

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	39	39
A Through	2	400	505
A Right Turn	.5	105	0
B Left Turn	1	244	244
B Through	1.5	659	360
B Right Turn	.5	60	0
C Left Turn	.5	23	0
C Through	.5	39	62
C Right Turn	1	280	280
D Left Turn	.3	24	0
D Through	.4	28	111
D Right Turn	.3	59	0

Probable Phase	Critical Volume	Carry-over
1+5	39	205
1+6 or 2+5	205	155
6+2	505	
4+7	111	0
3+8	62	218
8 RT on 1		TRUE

Sum of Crit. Vol.: 922
Volume/Capacity: 0.67
Level of Service: B

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
2	0.70
8	0.80
13	0.90
17	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:

A: 8odega Avenue	Eb		D
B: Sebastopol Avenue	Wb	A	B
C: South Main Street	Nb		C
0: Main Street	Sb		

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (2)

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	64	64
A Through	.5	256	344
A Right Turn	.5	88	0
8 Left Turn	1	171	171
B Through	1	452	452
8 Right Turn	1	238	238
C Left Turn	1	110	110
C Through	1	549	549
C Right Turn	1	20	20
0 Left Turn	I	159	159
D Through	1	488	488
0 Right Turn	1	46	46

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	345
6+2	345	
3+7	110	49
3+8 or 4+7	49	439
4+8	549	

Sum of Crit. Vol.: 1224
Volume/Capacity: 0.89
Level of Service: D

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
NA	0.80
1	0.90
5	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
0	1225
E	1375

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal, Tee intersection)

Intersection:

		Width
A: Main Street	Sb	
B: Main Street	Nb	A B
C: McKinley Street	Wb	50 C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (2)

Movement	Lanes		Volume	Lane Volume	Pedestrian Equivalent		Probable Cycle Length: 100 sec
A Through	2	.5	826	860			
A Right Turn		.5	34	0			
B Left Turn	1	1	58	58			
8 Through	6	1	718	718			
C Left Turn	3	1	90	90			
					C Ped 8W	252	
C Right Turn		1	125	125			

	Probable Phase	Critical Volume	Carry-over	Crit Vol with Ped
	1+6	58	660	58
	6+2	860		860
				0
	3+8	90	35	252
	8 RT on 1		TRUE	
Sum of Crit. Vol.:		1008		1170
Volume/Capacity:		0.71		0.82
Level of Service:		C		0

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
6	0.80
10	0.90
15	1.00

LEVEL OF SERVICE RANGES (3 phases)

Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

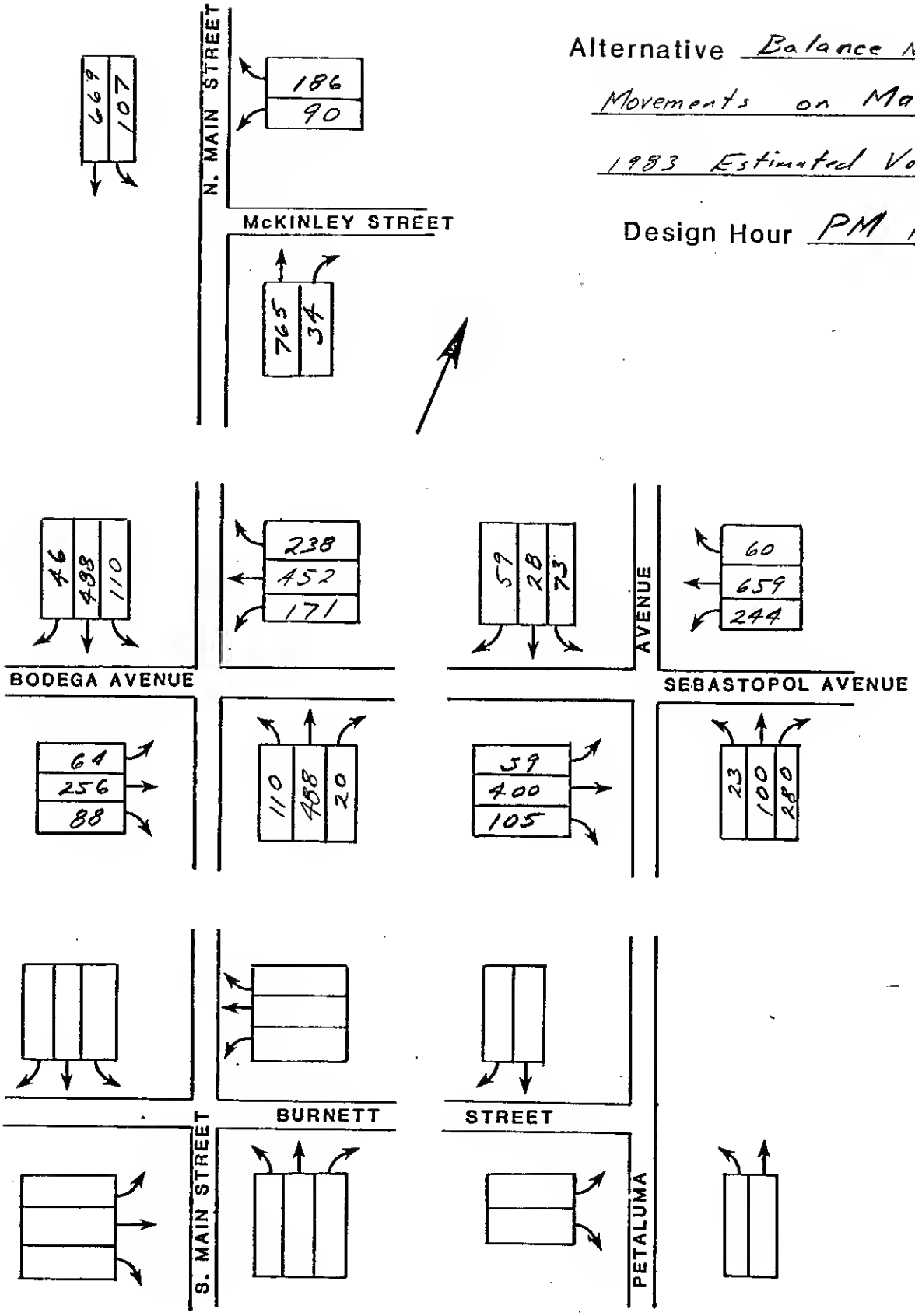
Ref: Interim Materials on Highway Capacity, TR8 Circular 212, Jan 1980

Alternative Balance N-S

Movements on Main Street

1983 Estimated Volumes

Design Hour PM Peak

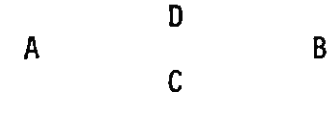


Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:

A: Bodega Avenue	Eb	
B: Sebastopol Avenue	Wb	
C: South Main Street	Nb	
D: Main Street	Sb	



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
Balanced N-S Movements (2a)

Movement	Lanes	Volume	Lane Volume
A Left Turn	5	1	64	64
A Through	2	.5	256	344
A Right Turn		.5	88	0
B Left Turn	1	1	171	171
B Through	6	1	452	452
B Right Turn		1	238	238
C Left Turn	3	1	110	110
C Through	8	1	488	488
C Right Turn		1	20	20
D Left Turn	7	1	110	110
D Through	4	1	488	488
D Right Turn		1	46	46

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	345
6+2	345	
3+7	110	0
3+8 or 4+7	0	488
4+8	488	

Sum of Crit. Vol.: 1114
Volume/Capacity: 0.81
Level of Service: D

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
NA	0.80
5	0.90
9	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
8	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TR8 Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal, Tee intersection)

Intersection:

		Width
A: Main Street	Sb	
B: Main Street	Nb	A B
C: McKinley Street	Wb	50 C

Oesign Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (2a)
Balance N-S Movements on Main Street

Movement	Lanes		Volume	Lane Volume	Pedestrian Equivalent		Probable Cycle Length: 100 sec
A Through	2	.5	765	799			
A Right Turn		.5	34	0			
B Left Turn	1	1	107	107			
B Through	6	1	669	669			
C Left Turn	3	1	90	90			
					C Ped 8W	252	
C Right Turn		1	186	186			

Probable Phase	Critical Volume	Carry-over	Crit Vol with Ped
1+6	107	562	107
6+2	799		799
			0
3+8	90	96	252
8 RT on 1		TRUE	
Sum of Crit. Vol.:	996		1158
Volume/Capacity:	0.70		0.81
Level of Service:	B-C		D

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
1	0.70
6	0.80
11	0.90
15	1.00

LEVEL OF SERVICE RANGES (3 phases)

Level of Service	Sum of Critical Volumes
A	855
8	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(6 Phase Dual Left Split Cross Street Signal)

Intersection:

A: Sebastopol Avenue	Eb		D
B: Sebastopol Avenue	Wb	A	B
C: Petaluma Avenue	Nb		C
D: Petaluma Avenue	Sb		

Design Hour: P M Peak

Problem Statement: 1983 Estimated Volumes (2a)
Balance N-S Movements on Main Street

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	39	39
A Through	.5	400	505
A Right Turn	.5	105	0
B Left Turn	1	244	244
B Through	1.5	659	360
B Right Turn	.5	60	0
C Left Turn	.5	23	0
C Through	.5	100	123
C Right Turn	1	280	280
D Left Turn	.3	73	0
D Through	.4	28	160
D Right Turn	.3	59	0

Probable Phase	Critical Volume	Carry-over
1+5	39	205
1+6 or 2+5	205	155
6+2	505	
4+7	160	0
3+8	123	157
8 RT on 1		TRUE

Sum of Crit. Vol.: 1032
Volume/Capacity: 0.75
Level of Service: C

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
3	0.80
8	0.90
12	1.00

LEVEL OF SERVICE RANGES (4+ phases)

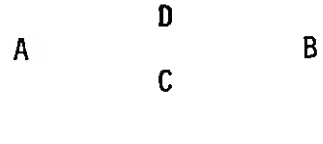
Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TR8 Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:
A: Bodega Avenue — Eb
8: Sebastopol Avenue — Wb
C: South Main Street — Nb
D: Main Street — Sb



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (3)
Remove Parking Main Street, Both sides

Movement		Lanes	Volume	Lane Volume
A Left Turn	5	1	64	64
A Through	2	.5	256	344
A Right Turn		.5	88	0
B Left Turn	1	1	171	171
B Through	6	1	452	452
8 Right Turn		1	238	238
C Left Turn	3	1	110	110
C Through	8	1.5	549	285
C Right Turn		.5	20	0
D Left Turn	7	1	159	159
D Through	4	1.5	488	267
D Right Turn		.5	46	0

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	345
6+2	345	
3+7	110	49
3+8 or 4+7	49	218
4+8	285	

Sum of Crit. Vol.: 960
Volume/Capacity: 0.70
Level of Service: B

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
1	0.70
6	0.80
11	0.90
15	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:

A: 8odega Avenue	Eb		D	
B: Sebastopol Avenue	Wb	A		8
C: South Main Street	Nb		C	
D: Main Street	Sb			

Design Hour: P M Peak

Problem Statement: 1983 Estimated Volumes (3a)
Remove Parking Main Street, West Side

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	64	64
A Through	.5	256	344
A Right Turn	.5	88	0
8 Left Turn	1	171	171
8 Through	1	452	452
8 Right Turn	1	238	238
C Left Turn	1	110	110
C Through	1	549	549
C Right Turn	1	20	20
D Left Turn	1	159	159
D Through	1.5	488	267
D Right Turn	.5	46	0

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	345
6+2	345	
3+7	110	49
3+8 or 4+7	49	218
4+8	549	

Sum of Crit. Vol.: 1224
Volume/Capacity: 0.89
Level of Service: D

Annual Growth Rate 2.45 %
Years 8efore: v/c exceeds

NA	0.60
NA	0.70
NA	0.80
1	0.90
5	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
8	965
C	1100
D	1225
E	1375

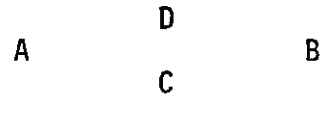
Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:

A: Bodega Avenue — Eb
B: Sebastopol Avenue — Wb
C: South Main Street — Nb
D: Main Street — Sb



Design Hour: P M Peak

Problem Statement: 1983 Estimated Volumes (3b)
Remove Parking Main Street, East Side

Movement	Phase	Lanes	Volume	Lane Volume
A Left Turn	5	1	64	64
A Through	2	.5	256	344
A Right Turn		.5	88	0
B Left Turn	1	1	171	171
B Through	6	1	452	452
B Right Turn		1	238	238
C Left Turn	3	1	110	110
C Through	8	1.5	549	285
C Right Turn		.5	20	0
D Left Turn	7	1	159	159
D Through	4	1	488	488
D Right Turn		1	46	46

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	345
6+2	345	
3+7	110	49
3+8 or 4+7	49	439
4+8	439	

Sum of Crit. Vol.: 1114
Volume/Capacity: D.81
Level of Service: D

Annual Growth Rate 2.45 %

Years Before: v/c exceeds	
NA	0.60
NA	0.70
NA	0.80
5	0.90
9	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
D	1225
E	1375

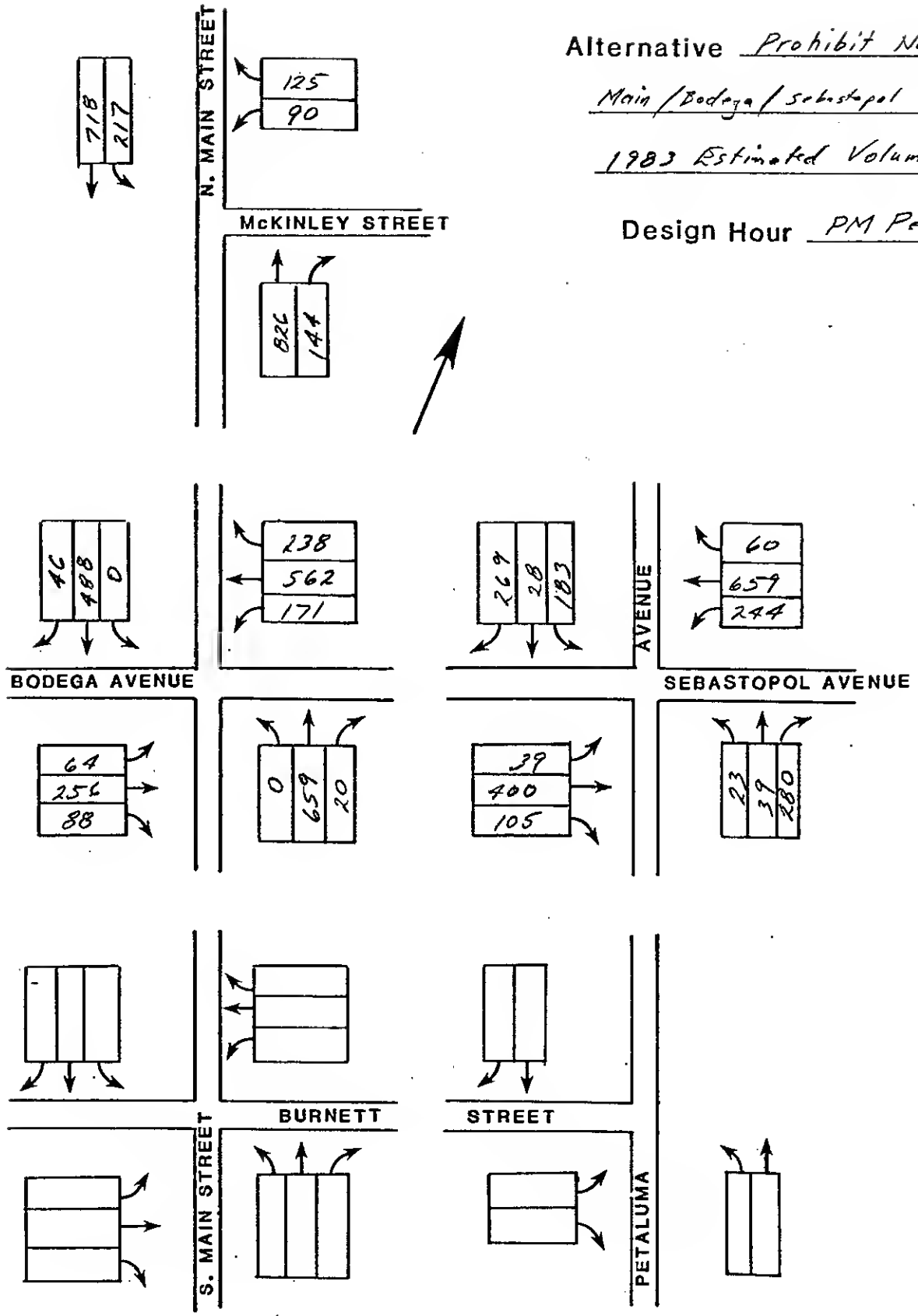
Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Alternative Prohibit NB, SB Left Turn

Main / Bodega / Sebastopol

1983 Estimated Volumes

Design Hour PM Peak



Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:

A: Bodega Avenue	Eb		D
8: Sebastopol Avenue	Wb	A	8
C: South Main Street	Nb		C
D: Main Street	Sb		

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (4)
No Left Turn Nb & Sb

Movement		Lanes	Volume	Lane Volume
A Left Turn	5	1	64	64
A Through	2	.5	256	344
A Right Turn		.5	88	0
8 Left Turn	1	1	171	171
B Through	6	1	562	562
8 Right Turn		1	238	238
C Left Turn	3	1	0	0
C Through	8	1	659	659
C Right Turn		1	20	20
0 Left Turn	7	1	0	0
0 Through	4	1	488	488
0 Right Turn		1	46	46

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	455
6+2	455	
3+7	0	0
3+8 or 4+7	0	488
4+8	659	

Sum of Crit. Vol.: 1285
Volume/Capacity: 0.93
Level of Service: E

Annual Growth Rate 2.45 %
Years Before: v/c exceeds

NA	0.60
NA	0.70
NA	0.80
NA	0.90
3	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
8	965
C	1100
0	1225
E	1375

Ref: Interim Materials on Highway Capacity, TR8 Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal, Tee intersection)

Intersection:
A: Main Street Sb
B: Main Street Nb
C: McKinley Street Wb

Width: A 50, B, C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
No LT Nb & Sb at Main/Bodega/Sebastopol (4)

Movement	Lanes	Volume	Lane Volume	Pedestrian Equivalent		Probable Cycle Length: 100 sec
A Through	2	.5	826	970		
A Right Turn		.5	144	0		
B Left Turn	1	1	217	217		
B Through	6	1	718	718		
C Left Turn	3	1	90	90		
				C Ped 8W	252	
C Right Turn		1	125	125		

Probable Phase	Critical Volume	Carry-over	Crit Vol with Ped
1+6	217	501	217
6+2	970		970
			0
3+8	90	35	252
8 RT on 1		TRUE	
Sum of Crit. Vol.:	1277		1439
Volume/Capacity:	0.90		1.01
Level of Service:	D-E		E

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
NA	0.80
1	0.90
5	1.00

LEVEL OF SERVICE RANGES (3 phases)

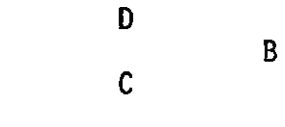
Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(6 Phase Dual Left Split Cross Street Signal)

Intersection:
A: Sebastopol Avenue Eb
B: Sebastopol Avenue Wb
C: Petaluma Avenue Nb
D: Petaluma Avenue Sb



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (4)
No LT Nb & Sb at Main/Bodega/Sebastopol

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	39	39
A Through	.5	400	505
A Right Turn	.5	105	0
8 Left Turn	1	244	244
8 Through	1.5	659	360
8 Right Turn	.5	60	0
C Left Turn	.5	23	0
C Through	.5	39	62
C Right Turn	1	280	280
D Left Turn	.3	183	0
D Through	.4	28	480
D Right Turn	.3	269	0

Probable Phase	Critical Volume	Carry-over
1+5	39	205
1+6 or 2+5	205	155
6+2	505	
4+7	480	0
3+8	62	218
8 RT on 1		TRUE

Sum of Crit. Vol.: 1291
Volume/Capacity: 0.94
Level of Service: E

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
NA	0.80
NA	0.90
3	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
8	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:

A: Bodega Avenue	Eb		O
B: Sebastopol Avenue	Wb	A	B
C: South Main Street	Nb		C
D: Main Street	Sb		

Design Hour: P M Peak

Problem Statement: 1983 Estimated Volumes (4a)
No Left Turn Nb & Sb. Add lanes Nb & Sb

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	64	64
A Through	.5	256	344
A Right Turn	.5	88	0
B Left Turn	1	171	171
B Through	1	562	562
B Right Turn	1	238	238
C Left Turn	0	0	0
C Through	1.5	659	340
C Right Turn	.5	20	0
O Left Turn	0	0	0
O Through	1.5	488	267
O Right Turn	.5	46	0

Probable Phase	Critical Volume	Carry-over
1+5	64	107
1+6 or 2+5	107	455
6+2	455	
3+7	0	0
3+8 or 4+7	0	267
4+8	340	

Sum of Crit. Vol.: 966
Volume/Capacity: 0.70
Level of Service: C

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
6	0.80
11	0.90
15	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal, Tee intersection)

Intersection:

		Width
A: Main Street	Sb	
B: Main Street	Nb	A B
C: McKinley Street	Wb	50 C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes. Add Nb RT Lane (4a)
No LT Nb & Sb at Main/Bodega/Sebastopol

Movement	Lanes	Volume	Lane Volume	Pedestrian Equivalent		Probable Cycle Length: 100 sec
A Through	2	1	826	826		
A Right Turn		1	144	144		
B Left Turn	1	1	217	217		
B Through	6	1	718	718		
C Left Turn	3	1	90	90		
				C Ped 8W	252	
C Right Turn		1	125	125		

	Probable Phase	Critical Volume	Carry-over	Crit Vol with Ped
	1+6	217	501	217
	6+2	826		826
				0
	3+8	90	35	252
	8 RT on 1		TRUE	
Sum of Crit. Vol.:		1133		1295
Volume/Capacity:		0.80		0.91
Level of Service:		C-D		E

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
1	0.80
6	0.90
10	1.00

LEVEL OF SERVICE RANGES (3 phases)

Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(6 Phase Dual Left Split Cross Street Signal)

Intersection:

A: Sebastopol Avenue	Eb		D	
B: Sebastopol Avenue	Wb	A		B
C: Petaluma Avenue	Nb		C	
D: Petaluma Avenue	Sb			

Design Hour: P M Peak

Problem Statement: 19B3 Estimated Volumes. 2 lanes Sb on Petaluma Ave
No LT Nb & Sb at Main/Bodega/Sebastopol (4a)

Movement	Lanes	Volume	Lane Volume
A Left Turn	1	39	39
A Through	.5	400	505
A Right Turn	.5	105	0
B Left Turn	1	244	244
B Through	1.5	659	360
B Right Turn	.5	60	0
C Left Turn	.5	23	0
C Through	.5	39	62
C Right Turn	1	280	280
D Left Turn	1	183	183
D Through	.5	28	297
D Right Turn	.5	269	0

Probable Phase	Critical Volume	Carry-over
1+5	39	205
1+6 or 2+5	205	155
6+2	505	
4+7	297	0
3+B	62	21B
B RT on 1		TRUE

Sum of Crit. Vol.: 110B
Volume/Capacity: 0.B1
Level of Service: D

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
NA	0.B0
5	0.90
9	1.00

LEVEL OF SERVICE RANGES (4+ phases)

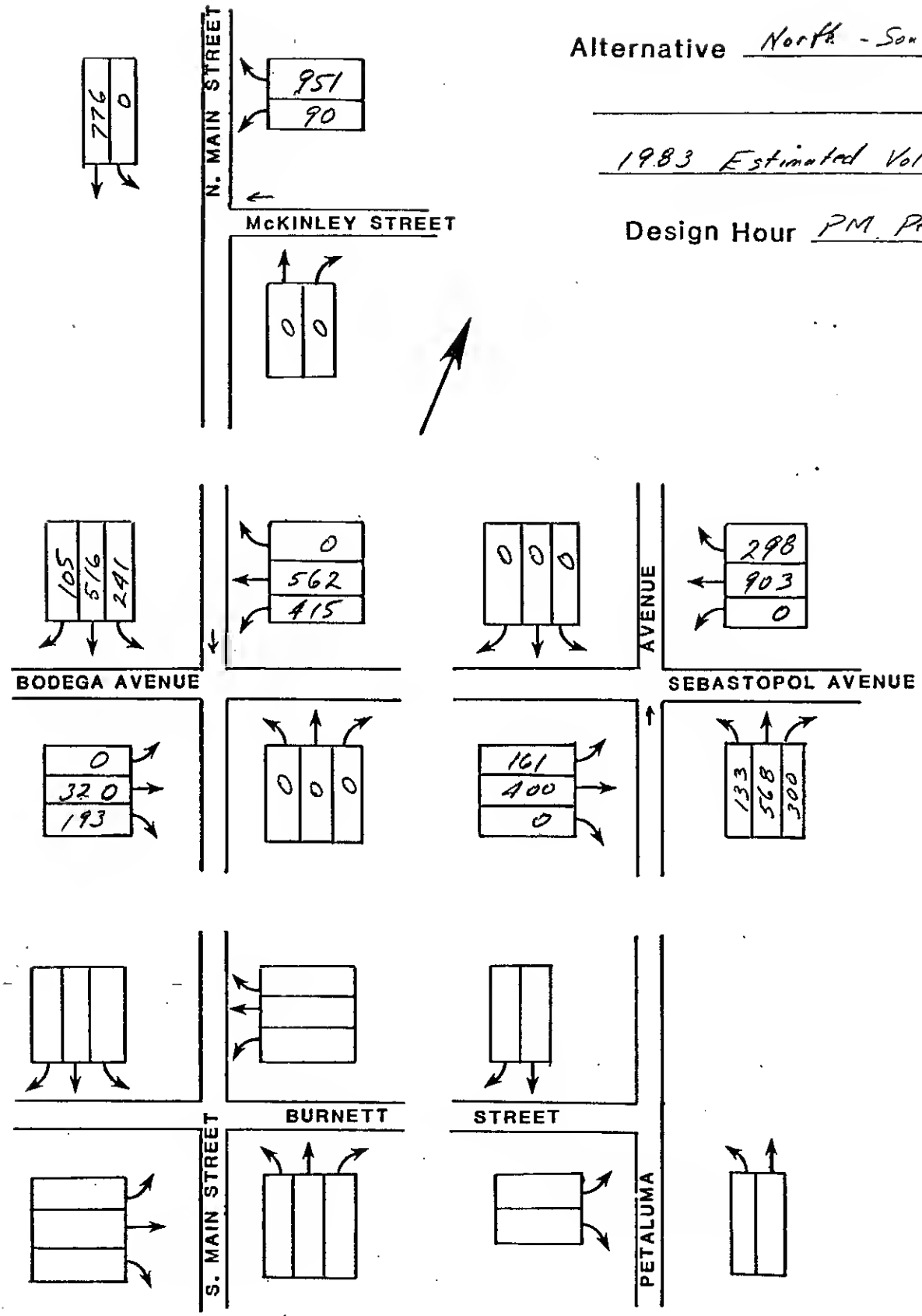
Level of Service	Sum of Critical Volumes
A	825
B	965
C	1100
D	1225
E	1375

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 19B0

Alternative North - South Couplet

1983 Estimated Volumes

Design Hour PM Peak



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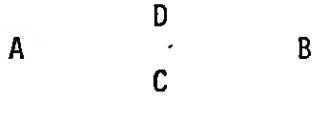
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(8 Phase Quad Left Signal)

Intersection:
A: Sebastopol Avenue — Wb
B: Bodega Avenue — Eb
C: Main Street — Sb
D: South Main Street



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5)
North-South Couplet

Movement	Lanes	Volume	Lane Volume
A Left Turn	5 1	415	415
A Through	2 1	562	562
A Right Turn	0	0	0
B Left Turn	1 0	0	0
B Through	6 1	320	320
B Right Turn	1	193	193
C Left Turn	3 .5	241	0
C Through	8 2	516	287
C Right Turn	.5	105	0
D Left Turn	7 0	0	0
D Through	4 0	0	0
D Right Turn	0	0	0

Probable Phase	Critical Volume	Carry-over
1+5	0	415
1+6 or 2+5	415	147
6+2	320	
3+8	287	

Sum of Crit. Vol.: 1022
Volume/Capacity: 0.72
Level of Service: C

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
5	0.80
10	0.90
14	1.00

LEVEL OF SERVICE RANGES (3 phases)

Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Main Street
B: Main Street
C: Mc Kinley Street

Sb
Wb

Width
50

A
B
C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
N-S One Way Couplet

(5)

Movement	Lanes	Volume	Lane Volume	Pedestrian Equivalent		Probable Cycle Length: 100 sec
B Through	6	2	776	388		
C Left Turn	3	1	90	90		
				C Ped 8W	252	
C Right Turn	8	1	951	951		

Probable Phase	Critical Volume	Carry-over	Crit Vol with Ped
6	388		388
3+8	90	861	90
8 RT	473		473
8 RT on 6	0	388	
Sum of Crit. Vol.:	951		951
Volume/Capacity:	0.63		0.63
Level of Service:	B		B

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
5	0.70
10	0.80
15	0.90
19	1.00

LEVEL OF SERVICE RANGES (2 phases)

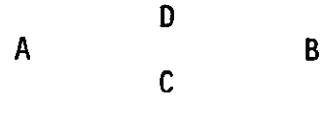
Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal)

Intersection:
A: Sebastopol Avenue Eb
B: Sebastopol Avenue Wb
C: Petaluma Avenue Nb
O: Petaluma Avenue



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5)
North-South Couplet

Movement	Lanes	Volume	Lane Volume
A Left Turn	5	1	161	161
A Through	2	1	400	400
A Right Turn		0	0	0
B Left Turn	1	0	0	0
B Through	6	1.5	903	601
B Right Turn		.5	298	0
C Left Turn	3	.5	133	0
C Through	8	1.5	568	351
C Right Turn		1	300	300
D Left Turn	7	0	0	0
O Through	4	0	0	0
D Right Turn		0	0	0

Probable Phase	Critical Volume	Carry-over
1+5	0	161
1+6 or 2+5	161	239
6+2	601	
3+8	351	

Sum of Crit. Vol.: 1112
Volume/Capacity: 0.78
Level of Service: C

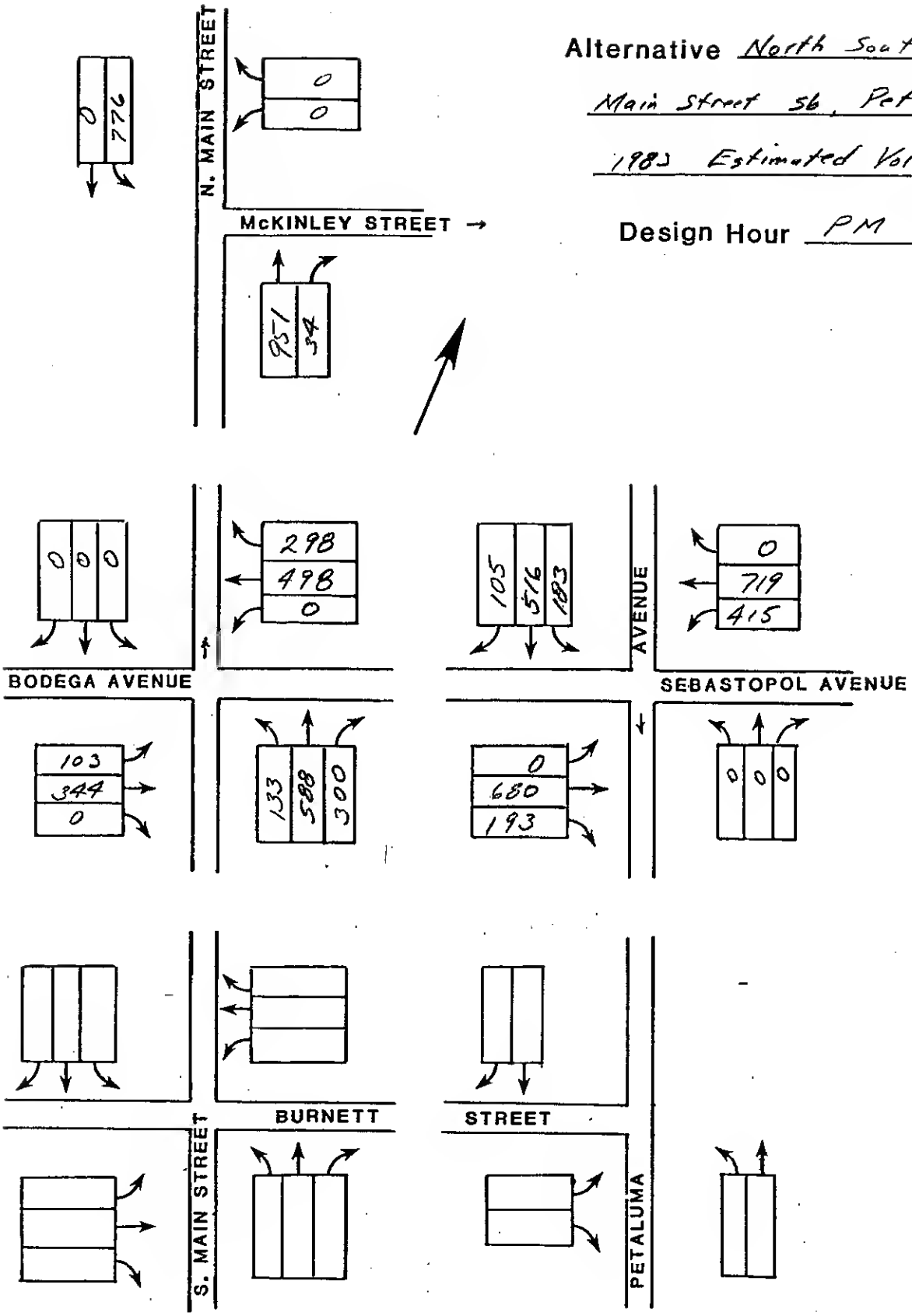
Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
NA	0.70
2	0.80
6	0.90
11	1.00

LEVEL OF SERVICE RANGES (3 phases)

Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980



Alternative North South Couplet Ga

Main Street 56, Petaluma Ave Nb

1983 Estimated Volumes

Design Hour PM Peak

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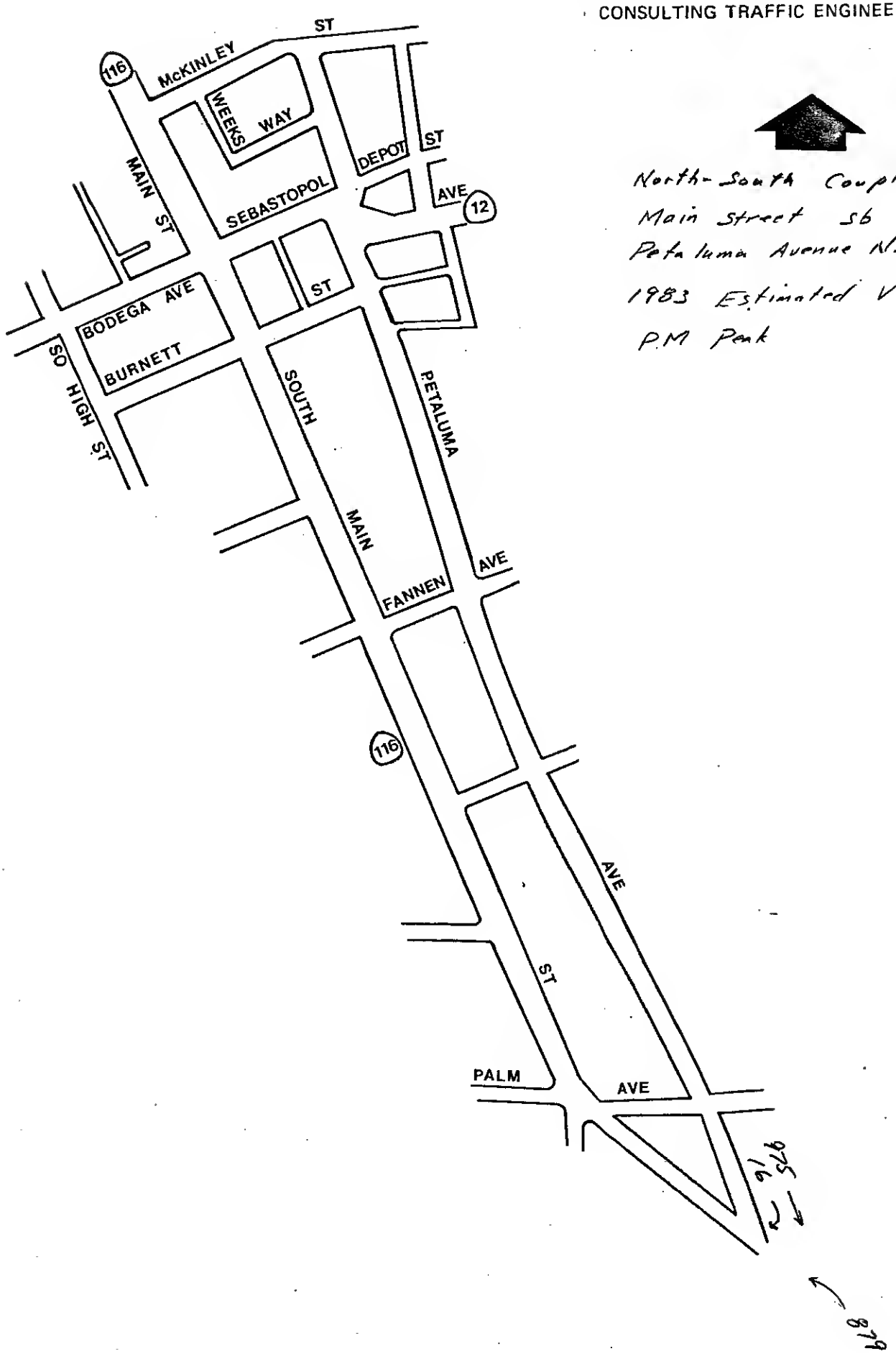
CONSULTING TRAFFIC ENGINEER



North-South Couplet (5a)
Main Street S6
Petaluma Avenue N6
1983 Estimated Volumes
P.M Peak

915 S
915 N

879

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Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Gravenstein Highway South NWb (2 lanes)
B: South Main Street A B
C: Petaluma Avenue Sb (1 lane) C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5a)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement	Phase	Lanes	Volume	Lane Volume
A Through	2	2	879	440
C Through	8	1	975	975
C Right Turn		1	16	16

Probable Phase	Critical Volume	Carry-over
2	440	
8	975	

Sum of Crit. Vol.: 1415
Volume/Capacity: 0.94
Level of Service: E

LEVEL OF SERVICE RANGES (2 phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

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Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Gravenstein Highway South NWb (1 lane)
8: South Main Street A B
C: Petaluma Avenue Sb (2 lanes) C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5a)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement	Phase	Lanes	Volume	Lane Volume
A Through	2	1	879	879
C Through	8	2	975	488
C Right Turn		1	16	16

Probable Phase	Critical Volume	Carry-over
2	879	
8	488	

Sum of Crit. Vol.: 1367
Volume/Capacity: 0.91
Level of Service: E

LEVEL OF SERVICE RANGES (2 phases)

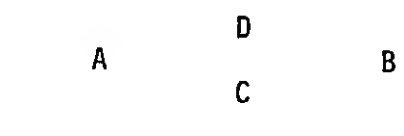
Level of Service	Sum of Critical Volumes
A	900
8	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal)

Intersection:
A: 8odega Avenue — Eb
B: Sebastopol Avenue — Wb
C: South Main Street — Nb
D: Main Street



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5a)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement	Phase	Lanes	Volume	Lane Volume
A Left Turn	5	1	103	103
A Through	2	1	344	344
A Right Turn		0	0	0
B Left Turn	1	0	0	0
B Through	6	1	498	498
B Right Turn		1	298	298
C Left Turn	3	.5	133	0
C Through	8	2	588	340
C Right Turn		.5	300	0
D Left Turn	7	0	0	0
D Through	4	0	0	0
D Right Turn		0	0	0

Probable Phase	Critical Volume	Carry-over
2+5	103	241
6+2	498	
3+8	340	

Sum of Crit. Vol.: 941
Volume/Capacity: 0.66
Level of Service: B

Annual Growth Rate 2.45 %
Years Before: v/c exceeds

Years Before	v/c exceeds
NA	0.60
3	0.70
8	0.80
13	0.90
18	1.00

LEVEL OF SERVICE RANGES (3 phases)

Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Main Street Nb
B: Main Street Sb
C: McKinley Street

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5a)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement	Lanes	Volume	Lane Volume
A Through	2	1.5	951	493
A Right Turn		.5	34	0
B Left Turn	1	1	776	776

Probable Phase	Critical Volume	Carry-over
1	776	0
2	493	

Sum of Crit. Vol.: 1269
Volume/Capacity: 0.85
Level of Service: D

Annual Growth Rate 2.45 %
Years Before: v/c exceeds

NA	0.60
NA	0.70
NA	0.80
3	0.90
7	1.00

LEVEL OF SERVICE RANGES (2 phases)

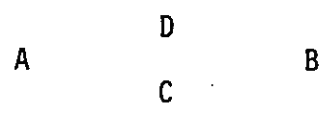
Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal)

Intersection:
A: Sebastopol Avenue Wb
B: Sebastopol Avenue Eb
C: Petaluma Avenue Sb
D: Petaluma Avenue



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5a)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement		Lanes	Volume	Lane Volume
A Left Turn	5	1	415	415
A Through	2	1	719	719
A Right Turn		0	0	0
B Left Turn	1	0	0	0
B Through	6	.5	680	873
B Right Turn		.5	193	0
C Left Turn	3	.5	183	0
C Through	8	1	516	402
C Right Turn		.5	105	0
O Left Turn	7	0	0	0
D Through	4	0	0	0
O Right Turn		0	0	0

Probable Phase	Critical Volume	Carry-over
2+5	415	304
6+2	873	
3+8	402	

Sum of Crit. Vol.: 1690
Volume/Capacity: 1.19
Level of Service: E

LEVEL OF SERVICE RANGES
(3 phases)

Level of Service	Sum of Critical Volumes
A	855
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Gravenstein Highway South NWb (2 lanes)
B: South Main Street A B
C: Petaluma Avenue Sb (2 lane) C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5b)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement	Lanes	Volume	Lane Volume
A Through	2	2 879	440
C Through	8	2 975	488
C Right Turn		1 16	16

Probable Phase	Critical Volume	Carry-over
2	440	
8	488	

Sum of Crit. Vol.: 927
Volume/Capacity: 0.62
Level of Service: B

Annual Growth Rate 2.45 %
Years Before: v/c exceeds

NA	0.60
6	0.70
11	0.80
16	0.90
20	1.00

LEVEL OF SERVICE RANGES (2 phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
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CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Main Street Nb
B: Main Street Sb
C: McKinley Street Nb

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5b)
North-South Couplet: Main St Nb, Petaluma Ave Sb

Movement	Phase	Lanes	Volume	Lane Volume
A Through	2	1.5	951	493
A Right Turn		.5	34	0
B Left Turn	1	2	776	388

Probable Phase	Critical Volume	Carry-over
1	388	0
2	493	

Sum of Crit. Vol.: 881
Volume/Capacity: 0.59
Level of Service: A

Annual Growth Rate 2.45 %
Years Before: v/c exceeds

Years Before	v/c exceeds
1	0.60
8	0.70
13	0.80
18	0.90
23	1.00

LEVEL OF SERVICE RANGES (2 phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(3 Phase Signal)

Intersection:
A: Sebastopol Avenue
B: Sebastopol Avenue
C: Petaluma Avenue
O: Petaluma Avenue

Wb
Eb (add RT lane)
Sb

D
A
B
C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes (5b)
North-South Couplet; Main St Nb, Petaluma Ave Sb

Movement	Lanes	Volume	Lane Volume
A Left Turn	5	1	415	415
A Through	2	1	719	719
A Right Turn		0	0	0
B Left Turn	1	0	0	0
B Through	6	1	6B0	6B0
B Right Turn		1	193	193
C Left Turn	3	.5	1B3	0
C Through	8	1	516	402
C Right Turn		.5	105	0
D Left Turn	7	0	0	0
O Through	4	0	0	0
O Right Turn		0	0	0

Probable Phase	Critical Volume	Carry-over
2+5	415	304
6+2	6B0	
3+B	402	

Sum of Crit. Vol.: 1497
Volume/Capacity: 1.05
Level of Service: E

LEVEL OF SERVICE RANGES
(3 phases)

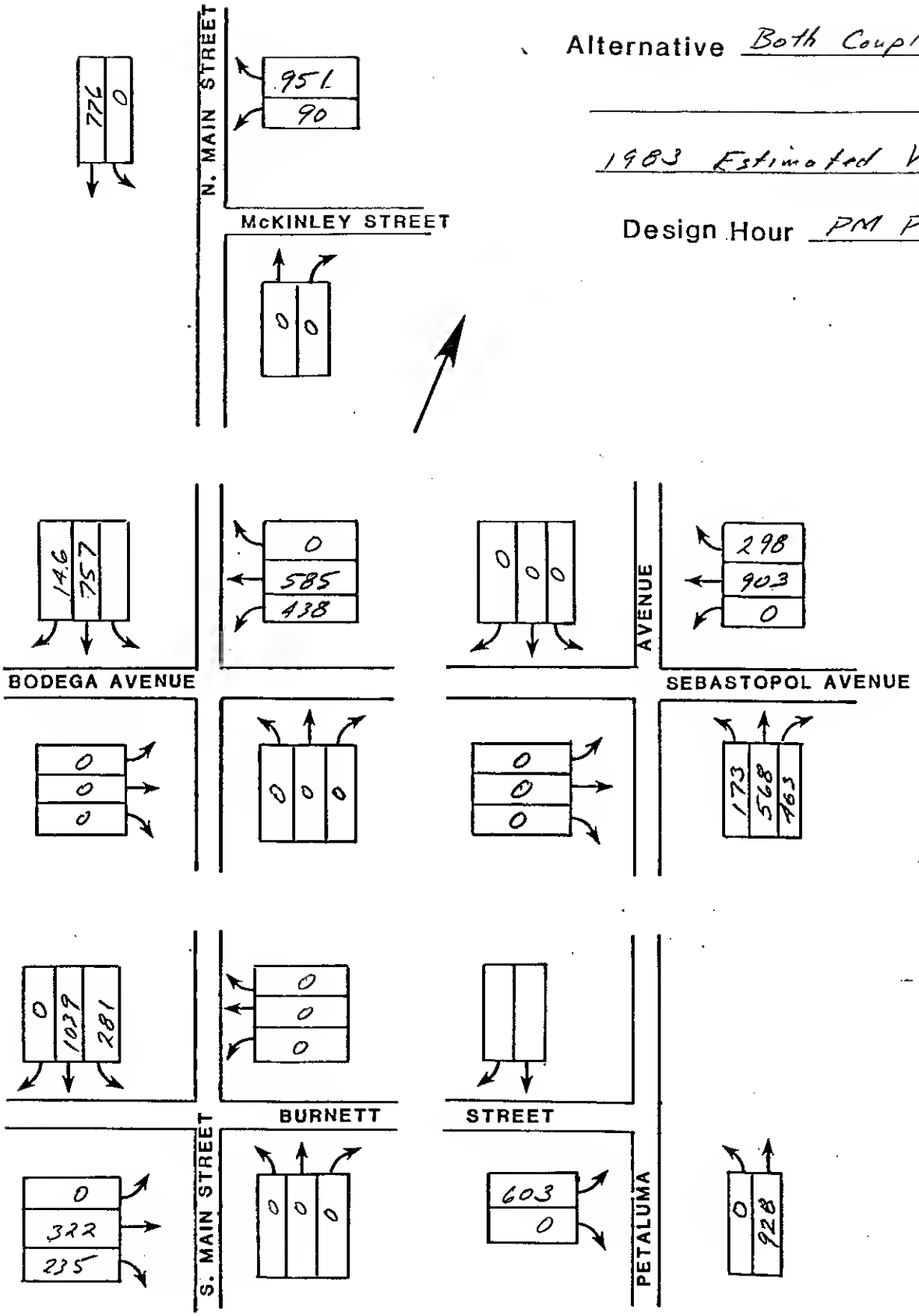
Level of Service	Sum of Critical Volumes
A	B55
B	1000
C	1140
D	1275
E	1425

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Alternative Both Couplets

1983 Estimated Volumes

Design Hour PM Peak



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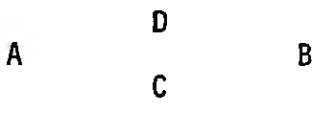
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: South Main Street
B: Main Street
C: Sebastopol Avenue
D: Bodega Avenue



Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
Both Couplets

(6)

Movement	Lanes	Volume	Lane Volume
B Through	6	2.5	757	301
B Right Turn		.5	146	
C Left Turn		1	438	512
C Through	8	1	585	

Probable Phase	Critical Volume	Carry-over
6	301	
8	512	

Sum of Crit. Vol.: 813
Volume/Capacity: 0.54
Level of Service: A

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
5	0.60
11	0.70
17	0.80
21	0.90
26	1.00

LEVEL OF SERVICE RANGES (2 phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Main Street
B: Main Street
C: Mc Kinley Street

Sb
Wb

Width: 50

A
B
C

Oesign Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
Both Couplets

(6)

Movement	Lanes	Volume	Lane Volume	Pedestrian Equivalent		Probable Cycle Length: 100 sec
B Through	6	2	776	388		
C Left Turn	3	1	90	90		
				C Ped 8W	252	
C Right Turn	8	1	951	951		

	Probable Phase	Critical Volume	Carry-over	Crit Vol with Ped
	6	388		388
	3+8	90	861	90
	8 RT	473		473
	8 RT on 6	0	388	
Sum of Crit. Vol.:		951		951
Volume/Capacity:		0.63		0.63
Level of Service:		B		B

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
5	0.70
10	0.80
15	0.90
19	1.00

LEVEL OF SERVICE RANGES (2 phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
0	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

Walter W. Laabs Jr., P. E.
Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal without conflicts)

Intersection:
A: Petaluma Avenue
B: Petaluma Avenue
C: Sebastopol Avenue
D: Sebastopol Avenue

Nb
Wb

D
A B
C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
Both Couplets

(6)

Movement	Lanes	Volume	Lane Volume
A Left Turn	5	.5	173	0
A Through	2	1.5	568	371
A Right Turn		1	463	463
C Through	8	1.5	903	601
C Right Turn		.5	298	0

Probable Phase	Critical Volume	Carry-over
5+2	371	93
2 RT on 8		TRUE
8	601	

Sum of Crit. Vol.: 971
Volume/Capacity: 0.65
Level of Service: B

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
NA	0.60
4	0.70
9	0.80
14	0.90
18	1.00

LEVEL OF SERVICE RANGES (4+ phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

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Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: South Main Street
B: South Main Street
C: Burnett Street
D: Burnett Street

Sb
Eb
A
B
C
D

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
Both Couplets (6)

Movement		Lanes	Volume	Lane Volume
A Left Turn		1	281	281
A Through	2	2	1039	520
C Through	8	1.5	322	279
C Right Turn		.5	235	

Probable Phase	Critical Volume	Carry-over
2	520	
8	279	

Sum of Crit. Vol.: 798
Volume/Capacity: 0.53
Level of Service: A

Annual Growth Rate 2.45 %

Years Before:	v/c exceeds
5	0.60
12	0.70
17	0.80
22	0.90
27	1.00

LEVEL OF SERVICE RANGES
(2 phases)

Level of Service	Sum of Critical Volumes
A	900
B	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980

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Consulting Traffic Engineer

CRITICAL MOVEMENT ANALYSIS
(2 Phase Signal, No conflicts)

Intersection:
A: Petaluma Avenue
B: Petaluma Avenue
C: Burnett Street

Nb
Eb

A B C

Design Hour: P M Peak
Problem Statement: 1983 Estimated Volumes
Both Couplets

(6)

Movement	Lanes	Volume	Lane Volume
B Through	6	2	928	464
C Left Turn	8	2	603	302

Probable Phase	Critical Volume	Carry-over
6	464	
8	302	

Sum of Crit. Vol.: 766
Volume/Capacity: 0.51
Level of Service: A

Annual Growth Rate 2.45 %
Years Before: v/c exceeds

Years Before	v/c exceeds
7	0.60
14	0.70
19	0.80
24	0.90
28	1.00

LEVEL OF SERVICE RANGES (2 phases)

Level of Service	Sum of Critical Volumes
A	900
8	1050
C	1200
D	1350
E	1500

Ref: Interim Materials on Highway Capacity, TRB Circular 212, Jan 1980